PRELIMINARY

Operator's Manual
The Coherent
Model 599 Standing Wave Dye Laser

COHERENT.
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Table of Contents

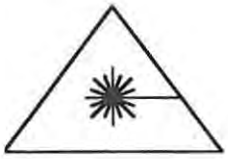
List of Illustrations

List of Tables

PREFACE

This manual contains user information for the Model 599 Standing Wave Dye Laser and the Model 5920 Dye Circulator. Information on other instruments used in conjuction with the dye laser is located in the respective operator's manual.

Read this manual carefully before operating the laser for the first time. Special attention should be given to the material in Chapter One, Laser Safety, that describes the safety features built into the Laser.



Use of controls or adjustments or performance of procedures other than those specified in this manual may result in hazardous radiation exposure.

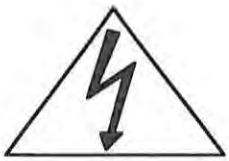
U.S. Export Control Laws Compliance

It is the policy of Coherent to comply strictly with U.S. export control laws.

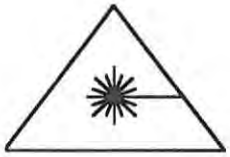
Export and re-export of lasers manufactured by Coherent are subject to U.S. Export Administration Regulations, which are administered by the Commerce Department. In addition, shipments of certain components are regulated by the State Department under the International Traffic in Arms Regulations.

The applicable restrictions vary depending on the specific product involved and its destination. In some cases, U.S. law requires that U.S. Government approval be obtained prior to resale, export or re-export of certain articles. When there is uncertainty about the obligations imposed by U.S. law, clarification should be obtained from Coherent or an appropriate U.S. Government agency.

Symbols Used in This Document



This symbol is intended to alert the operator to the presence of dangerous voltage within the product's enclosure that may be of sufficient magnitude to constitute a risk of electric shock and to indicate possible risk of equipment damage.



This symbol is intended to alert the operator to the danger of exposure to hazardous visible and invisible laser radiation.

This symbol is intended to emphasize the presence of important operating and maintenance instructions.

OPERATOR'S MANUAL

CHAPTER ONE
LASER SAFETY

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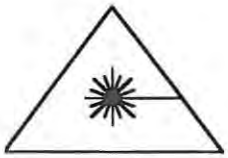
Optical Safety

Laser light, because of its special properties, poses safety hazards not associated with light from conventional sources. The safe use of lasers requires that all laser users, and everyone near the laser system, are aware of the dangers involved. The safe use of the laser depends upon the user being familiar with the instrument and the properties of intense beams of coherent light.

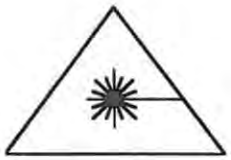


Direct eye contact with the output beam from the laser will cause serious damage and possible blindness.

The greatest concern when using a laser is eye safety. In addition to the main beam, there are often many smaller beams present at various angles near the laser system. These beams are formed by specular reflections of the main beam at polished surfaces such as lenses or beamsplitters. While weaker than the main beam, such beams may still be sufficiently intense to cause eye damage.

Laser beams are powerful enough to burn skin, clothing or paint. They can ignite volatile substances such as alcohol, gasoline, ether and other solvents, and can damage light-sensitive elements in video cameras, photomultipliers and photodiodes. The laser beam can ignite substances in its path, even at some distance. The beam may also cause damage if contacted indirectly from reflective surfaces. For these reasons, and others, the user is advised to follow the precautions below.

- Observe all safety precautions in the preinstallation and operator's manual.
- Extreme caution should be exercised when using solvents in the area of the laser.
- Limit access to the laser to qualified users who are familiar with laser safety practices and who are aware of the dangers involved.
- Never look directly into the laser light source or at scattered laser light from any reflective surface. Never sight down the beam into the source.
- Maintain experimental setups at low heights to prevent inadvertent beam-eye encounter at eye level.



Laser safety glasses can present a hazard as well as a benefit; while they protect the eye from potentially damaging exposure, they block light at the laser wavelengths, which prevents the operator from seeing the beam. Therefore, use extreme caution even when using safety glasses.

- As a precaution against accidental exposure to the output beam or its reflection, the user and anyone in the vicinity of the laser should wear laser safety glasses as required by the wavelengths being generated including the pump laser. Refer to the *Laser Focus World Buyer's Guide* or to the *Rockwell Laser Industries catalogue* for suppliers of protective eyewear.
- Avoid direct exposure to the laser light. The intensity of the beam can easily cause flesh burns or ignite clothing.
- Use the laser in an enclosed room. Laser light will remain collimated over long distances and therefore presents a potential hazard if not confined.
- Post warning signs in the area of the laser beam to alert those present.
- Advise all those using the laser of these precautions. It is good practice to operate the laser in a room with controlled and restricted access.

For additional information on laser safety, refer to the following publications:

- *Laser Safety Comes to Light* (videotape). ©Coherent, Inc., 1988.
- *American National Standard for the Safe Use of Lasers, Z136.1-1993*, American National Standards Institute, 1993.
- *Performance Standard for Laser Products.* FDA., (FR-40) (148): 32252-32265. Department of Health, Education and Human Service Bureau of Radiological Health, July 31, 1974.
- *Laser Safety Guide,* Laser Institute of America. (9th Edition). Orlando, FL 1993.
- D. Sliney and M. Wolbarsht. *Safety with Lasers and Other Optical* Sources. Plenum Publishing Company, New York, N.Y., 1980.

Electrical Safety

No electrical power is applied to the dye laser head.

Pump Source

Observe all safety precautions associated with the pump laser. Refer to the pump laser operator's manual for additional safety precautions.

CDRH Compliance

The following safety features incorporated in the laser conform to United States Government requirements 21 CFR Subchapter J as administered by the Center for Devices and Radiological Health (CDRH).

Protective Housing

The laser head is enclosed in a protective housing which prevents human access in excess of the limits of class one radiation as specified in the Federal Register, July 31, 1975, Part II, Section 1040.10 (f) (1) and Table 1-A except for the output beam which is class 4.

Location of CDRH Compliance Labels

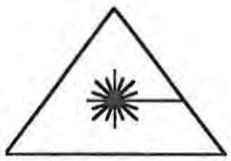
Refer to Figure 1-1 for a description and location of all CDRH required labels. These include warning labels indicating removable or displaceable protective housings, apertures through which laser radiation is emitted and labels of certification and identification (CFR 1040.10(g)), (CFR 1010.2), and (CFR 1010.3).

- When the pumping beam is allowed to impinge on the dye jet, both laser and collateral radiation are produced. The laser beam is emitted from the laser aperture which is clearly labeled:

  AVOID EXPOSURE
  VISIBLE AND
  INVISIBLE LASER RADIATION
  IS EMITTED
  FROM THIS APERTURE.

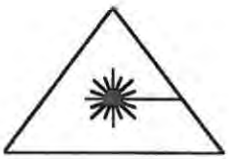
- The laser is designed to be used with the covers in position and this cover shields the operator from all collateral radiation. During initial alignment and maintenance operations, such as mirror alignment, it will be necessary to remove the covers. The covers are not interlocked with the circuitry of the pumping laser

but a label provides a warning about exposure to the radiation.



Operation of laser with covers removed will allow access to hazardous visible and invisible radiation. The laser housings should only be opened for the purposes of maintenance and service by trained personnel cognizant of the hazards involved. Extreme caution must be observed in operating the laser with covers removed. There are high-power reflections which may exit at unpredictable angles from the laser head. These beams have sufficient energy density to cause permanent eye damage or blindness.

The Center for Devices and Radiological Health regulations apply only within the United States.



Use of controls or adjustments, or performance of procedures other than those specified herein, may result in hazardous radiation exposure.

Operating Controls

All operating controls are located in such a way that the operator need not be exposed to laser emission while manipulating the controls (CFR 1040.10(f)(7)).

CDRH Compliance

Effective August 2, 1976, Coherent lasers are certified to comply with the Federal Regulations (21 CFR Subchapter J) as administered by the Center for Devices and Radiological Health.

The Model 599 laser does not include an integral power source; it utilizes the output beam of an ion laser to produce coherent light.

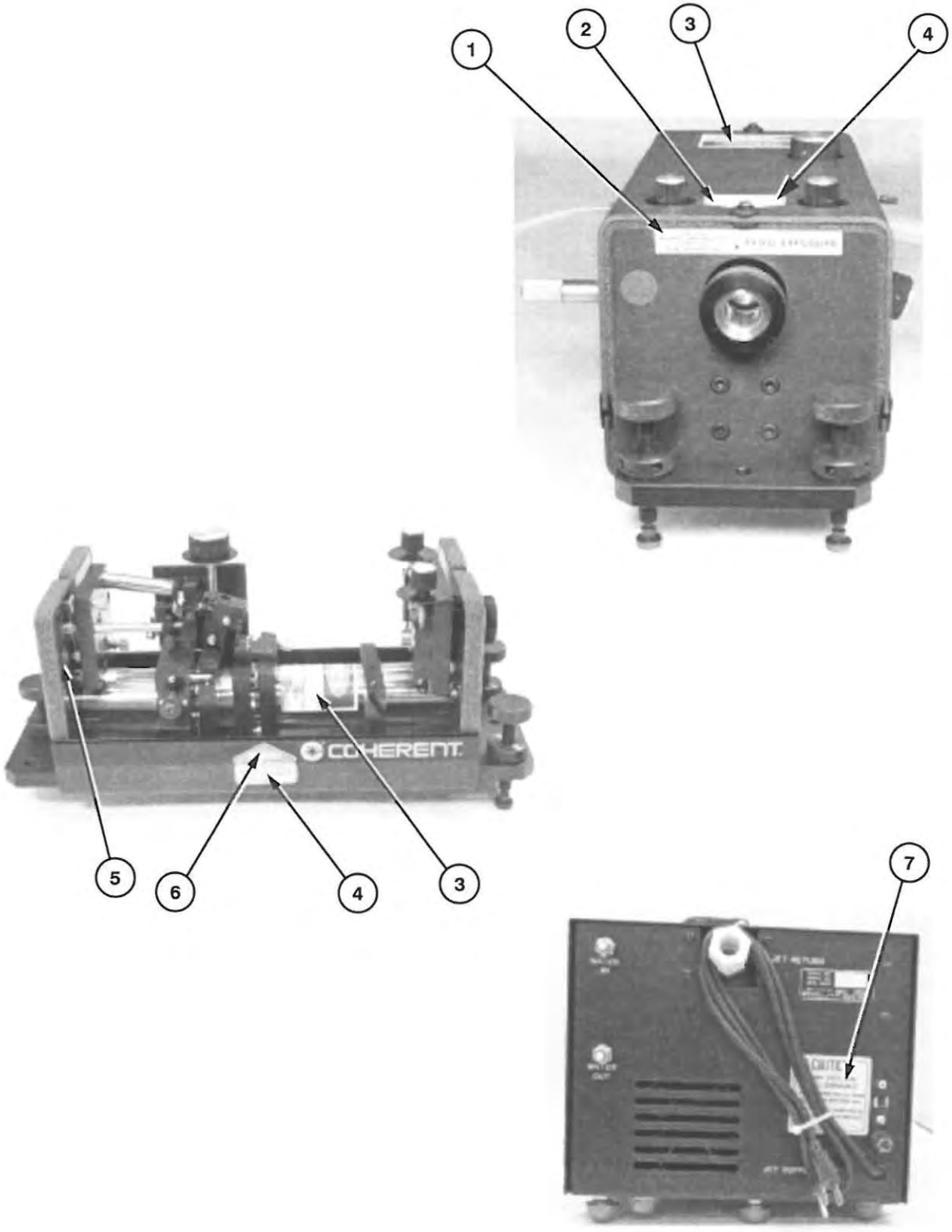


Figure 1-1. Safety Labels Location (Sheet 1 of 3)

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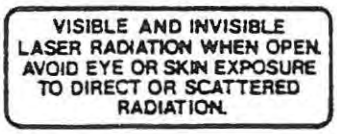

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Figure 1-1. Safety Labels Location (Sheet 2 of 3)

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6

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Figure 1-1. Safety Labels Location (Sheet 3 of 3)

OPERATOR'S MANUAL

CHAPTER TWO
DESCRIPTION AND SPECIFICATIONS

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Description

The Model 599 Standing Wave Dye Laser system (Figure 2-1) consists of a dye laser head and a dye circulator.

Laser Head

All components in the laser head are mounted to a 2-inch diameter Invar rod for stability. The basic configuration is a 3-mirror cavity (Figure 2-3). The pump beam is focused on the dye in a direction not colinear with the laser mode by pump mirror P1.

The dye jet stream, which is oriented at Brewster's angle, compensates for the astigmatism introduced by the off-axis fold mirror. The jet stream is nominally 100 microns thick, 2 to 3 mm wide and flows at approximately 10 m/sec.

Birefringent Filter

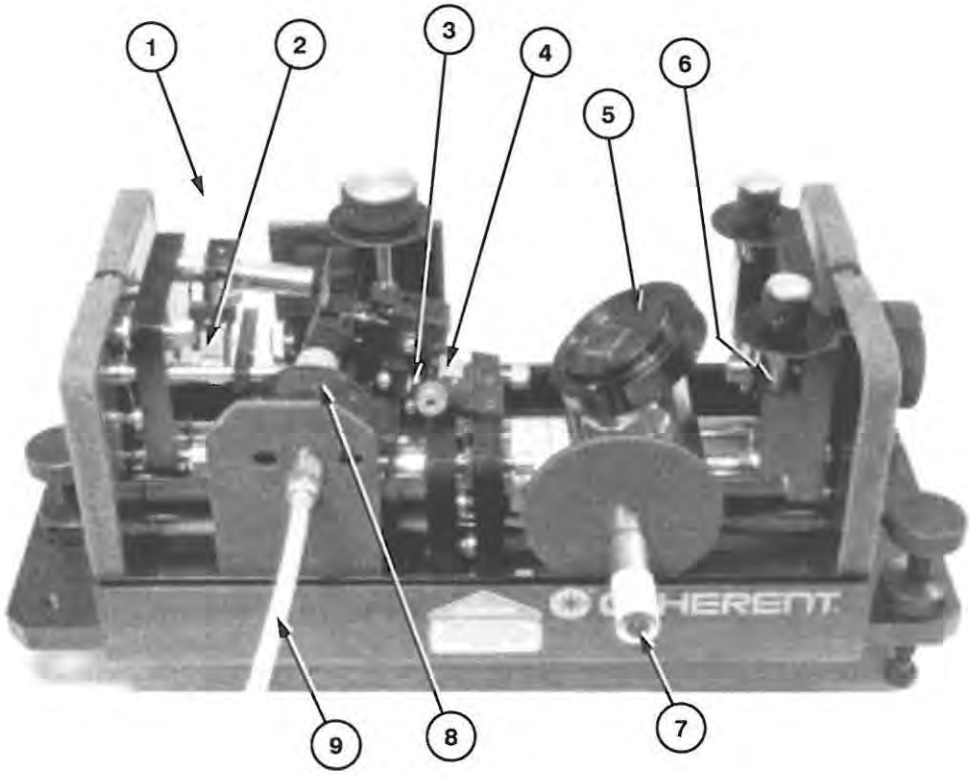
The 599 dye laser uses a low-loss crystalline-quartz birefringent filter (BRF) inserted in the highly stable three-mirror cavity. The BRF functions as a wavelength selector for the laser system. The filter consists of plate(s) oriented at Brewster's angle with the optical axis in the plane of the face. Rotation of the plates about an axis normal to the surfaces changes the output wavelength. Additional BRF information is located in Chapter Six, Theory of Operation.

Figure 2-1. Model 599 Standing Wave Dye Laser

To avoid possible damage, refer to the cleaning procedures in Chapter Seven, Maintenance, prior to cleaning the birefringent filter.

The birefringent filter, optics and type of dye — not the cavity alignment — determines the dye laser wavelength in the Model 599 Standing Wave Dye Laser. It can be used at any wavelength at which the dye will lase.

The birefringent filter is adjusted with a calibrated micrometer. A calibration curve is provided for the dye ordered.



1. Dye return hose
2. Fold mirror M2
3. Pump mirror P1
4. End mirror M1
5. Birefringent filter (BRF)
6. Output coupler M3
7. BRF micrometer
8. Dye jet translation assembly
9. Dye input hose

Figure 2-2. Major Laser Head Components

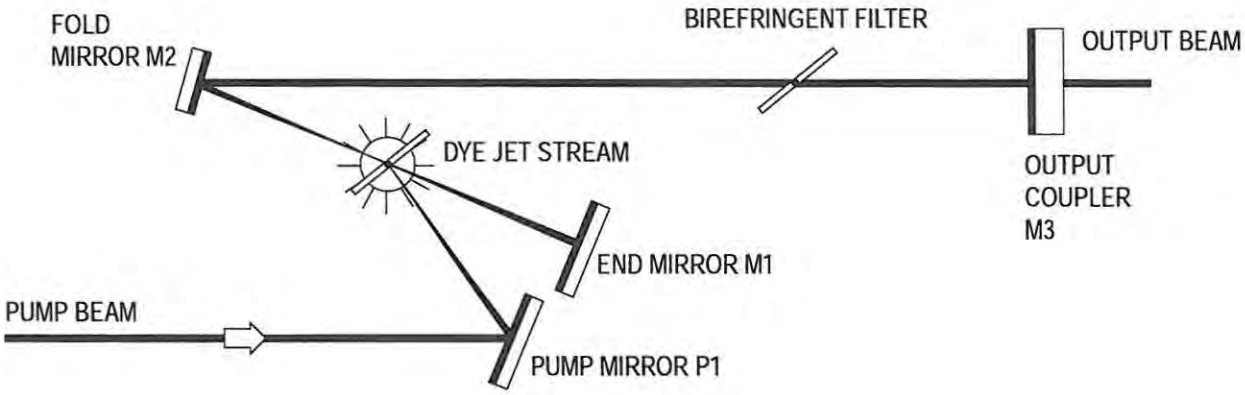


Figure 2-3. Optical Schematic

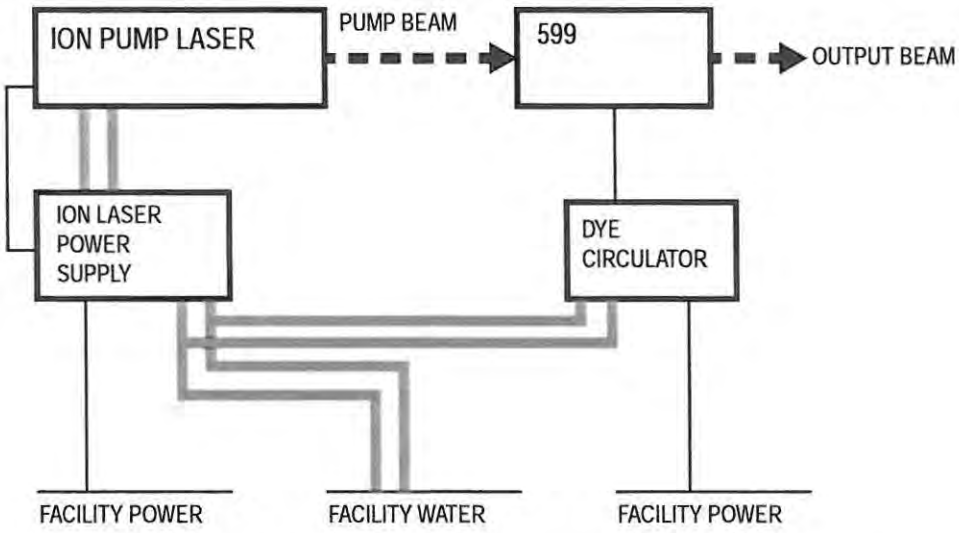


Figure 2-4. Typical System Configuration

Dye Circulator

The Model 5920 dye circulator cools, filters, and pumps the dye solution. It also controls the dye jet pressure and provides a reservoir of dye.

Table 2-1. Specifications

Specifications	
Output power	Refer to Table 2-3, Performance Summary
Mode	TEM_{00}
Polarization	Vertical
Beam diameter(1)	0.6 mm
Beam divergence(1)	1.5 mrad
Jitter	40 GHz (3-plate)
Effective linewidth	40 GHz (3-plate) 500 GHz (1-plate)(3)
Power stability(2)	3% per day
Noise(2)	1% rms, 10 Hz to 100 kHz

Specifications are subject to change without notice.

1 Nominal: depends on wavelength and cavity alignment.

2 The dye laser output replicates the output of the pump laser. These numbers refer to the inherent properties of the dye laser.

3 500 GHz is a typical linewidth and is not a specification.

Table 2-2. Dimensions and Weights

	LASER HEAD	DYE CIRCULATOR
Length	66.0 cm (26.0 in)	30.8 cm (12.1 in)
Width	34.3 cm (13.5 in)	27.0 cm (10.6 in)
Height	20.5 cm (8.06 in)	25.4 cm (10.0 in)
Weight		

Table 2-3. Performance Summary

DYE	PUMP LASER[1] (Input Power/Wavelength)	TYPICAL TUNING RANGE - DYE LASER	OUTPUT POWER (mW) - DYE LASER
Exalite 392E	Multiline UV 5.0 W/333.6 to 363.8 nm	375 to 410 nm	200 mW
Stilbene 1/LC 4100	Multiline UV 2.5 W/333.6 to 363.8 nm	395 to 435 nm	130 mW
Stilbene 3/LC 4200	Multiline UV 2.5 W/333.6 to 363.8 nm	420 to 470 nm	360 mW
Coumarin 102/LC 4800	Multiline UV 2.5 W/333.6 to 363.8 nm	458 to 520 nm	480 mW
Coumarin 30/LC 5150	Multiline violet 2.5 W/406.7 to 415.1 nm	482 to 538 nm	250 mW
Coumarin 6/LC 5370	Singleline 3.0 W/488.0 nm	515 to 588 nm	240 mW
Rhodamine 110/LC 5700	Multiline blue/green 5.0 W/457.9 to 514.5 nm	335 to 600 nm	540 mW
Rhodamine 6G/LC 5900	Multiline blue/green 5.0 W/457.9 to 514.5 nm	566 to 640 nm	880 mW
Kiton red/LC 6200	Multiline blue/green 5.0 W/457.9 to 514.5 nm	602 to 695 nm	860 mW
DCM Special/LC 6501	Multiline blue/green 5.0 W/457.9 to 514.5 nm	608 to 712 nm	540 mW
Pyridine 2/LC 7300	Multiline blue/green 5.0 W/457.9 to 514.5 nm	680 to 795 nm	600 mW
LD700/LC 7000	Multiline red 4.6 W/647.1 to 676.4 nm	695 to 785 nm	1200 mW
Styryl 9M/LC 8400	Multiline blue/green 5.0 W/457.9 to 514.5 nm	790 to 940 nm	450 mW
Additional dye information including estimated dye lifetime is located in Appendix A.			

OPERATOR'S MANUAL

CHAPTER THREE
CONTROLS AND INDICATORS

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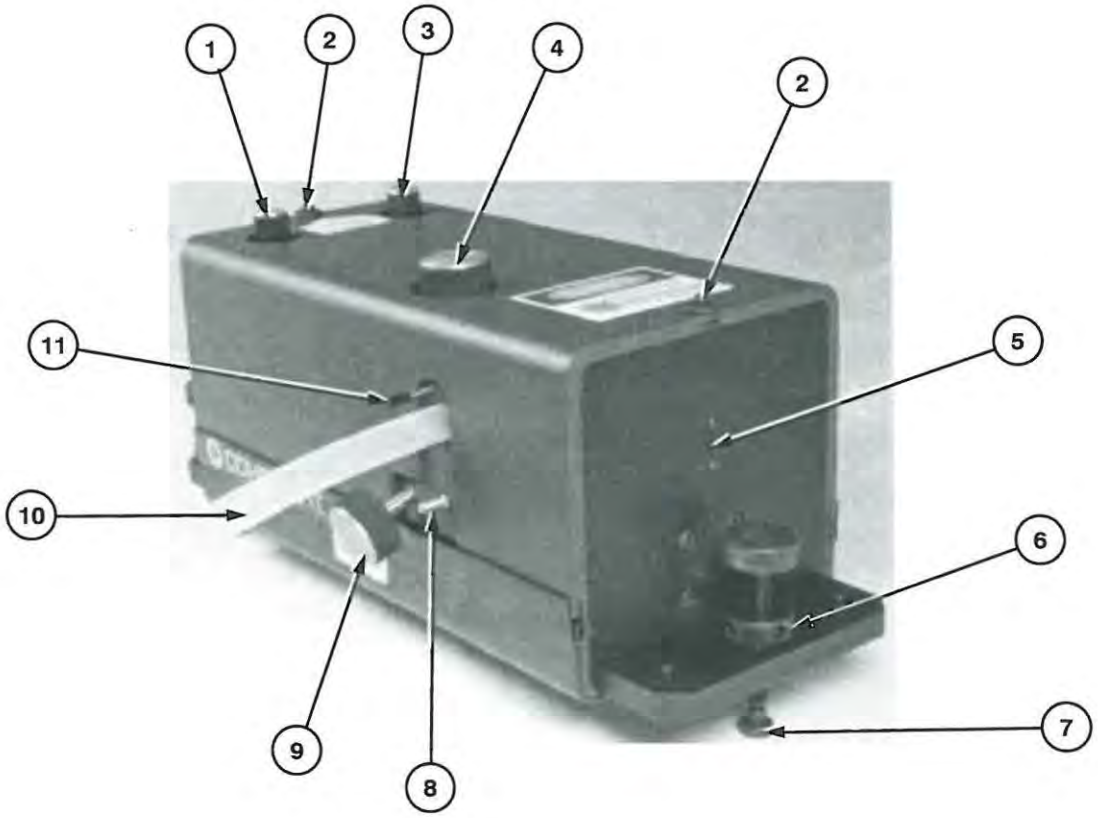
Controls and Indicators

Refer to Figure 2-2 for an optical schematic of the laser head.

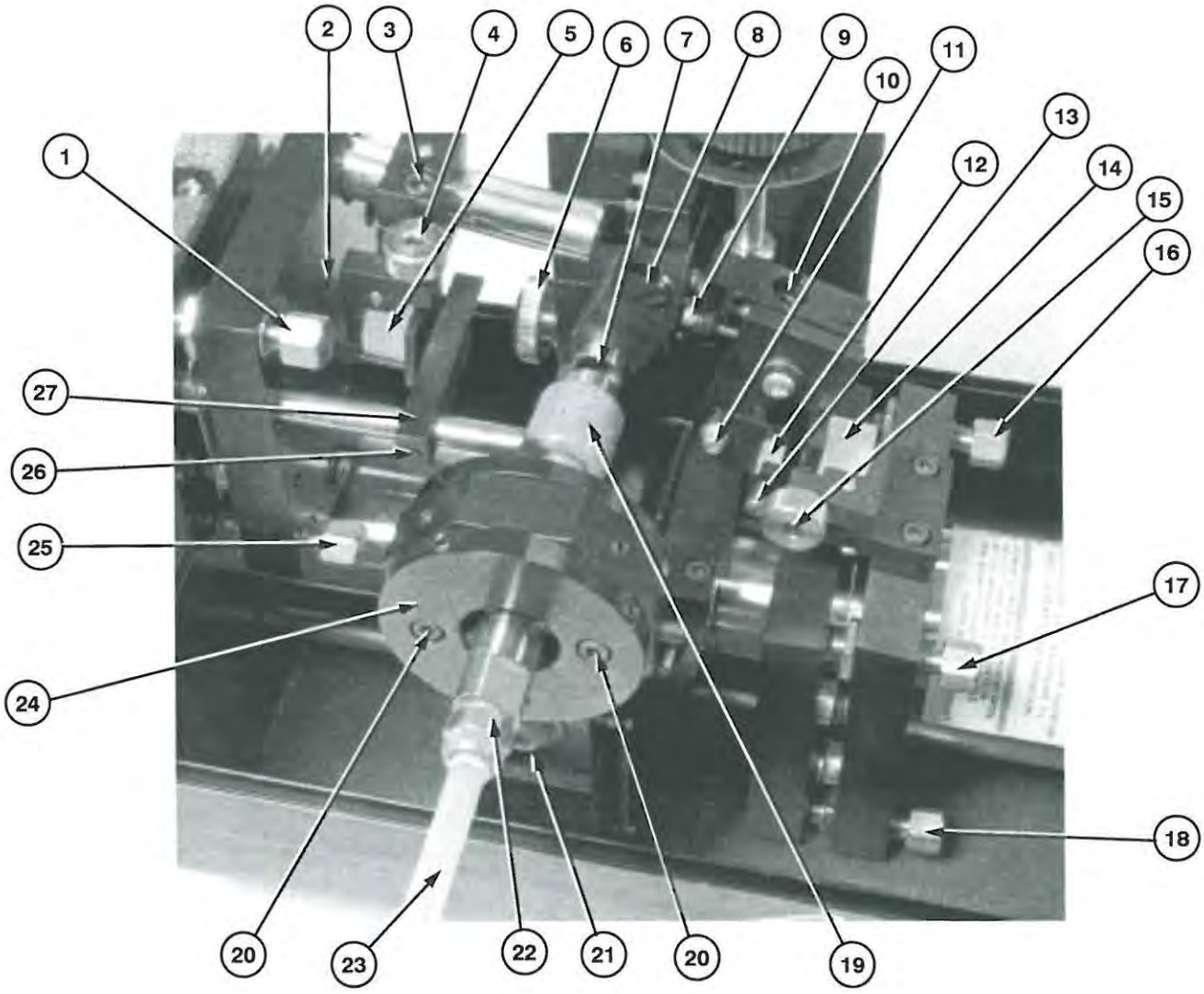


1. Output coupler horizontal tilt angle control
2. Head cover screws (2)
3. Output coupler vertical tilt angle control
4. Pump mirror vertical translation adjust
5. Pump beam input aperture
6. Height locking screws (3)
7. Laser head height/leveling adjustable foot (3)
8. Nitrogen purge connector
9. Pump mirror horizontal translation adjust
10. Dye return hose
11. Neutral density filter handle

Figure 3-1. Laser Head Controls – Cover On

Table 3-1. Laser Head Controls – Cover On

ITEM	CONTROL	FUNCTION
1, 3	Output coupler vertical and horizontal tilt angle controls	Allows horizontal and vertical tilt angle adjustment of the output coupler (M3) to optimize the laser output during operation. Also provides for adjustment of the fluorescent spot before lasing is established during alignment.
2	Head cover screws (2)	Laser head cover retaining screws. The cover should always be in place during operation.
4, 9	Pump mirror vertical and horizontal translation adjust	Allows adjustment of the pump mirror (M1) along the vertical and horizontal axis. These controls provide fine adjustment of the pump mirror to optimize the intersection of the dye jet stream with the pump beam. Other pump mirror adjustments are shown on Figure 3-2, items 10 and 11.
5	Pump beam input aperture	The incoming pump beam is centered in this aperture during dye laser installation.
6	Height locking screws (3)	Secures the laser head height and leveling adjustments. Refer to item 7.
7	Laser head height/leveling adjustable foot (3)	Allows leveling of the laser head and height adjustment of the dye laser to facilitate alignment of the incoming pump beam during installation. After adjustment, the height locking screws (item 6) should be tightened and the feet should be locked in place using the optional foot clamps.
8	Nitrogen purge connector	Depending on user requirements, the laser head can be purged with nitrogen (N_2) at X standard cubic feet per minute (X liters per minute) with XXXX% purity. N_2 is not required for proper operation, however; an N_2 purge can reduce the need for optics cleaning in a less than optimum environment.
10	Dye return hose	Returns dye to the reservoir in the dye circulator.
11	Neutral density filter handle	Allows positioning the neutral density filter over the intersection of the dye jet stream and the pump beam for viewing during alignment. A spring arm must be pushed back to reposition the filter. The handle also allows the catch tube cutout to be exposed for adjusting the position of the cutout to avoid clipping the pump beam. The neutral density filter is shown on Figure 3-2 (item 8).



1. M2 mount assembly pivot adjust
2. Pump mirror alignment hole
3. M2 mount assembly adjust
4. M2 optic mount assembly retaining screw
5. Fold mirror M2
6. Catch tube retaining screw
7. Catch tube pump beam cutout
8. Neutral density filter
- - Neutral density filter handle (refer to Figure 3-1)
9. P1 focus adjust
10. P1 coarse horizontal angle adjust
11. P1 mount rotational and vertical adjust
12. Pump mirror P1
13. P1 retaining screw
14. End mirror M1
15. M1 optic retaining screw
16. M1 horizontal tilt angle adjust
17. M1 mount assembly pivot adjust
18. M1 vertical tilt angle adjust
19. Dye jet stream boot
20. Jet translation assembly locking screws (2)
21. Jet translation assembly securing screw
22. Dye input hose locking nut
23. Dye input hose
24. Jet translation assembly
    (additional controls - refer to Figure 3-4)
25. M2 vertical tilt angle adjust
- - M2 horizontal tilt angle adjust (refer to Figure 3-X)
26. Pump beam dump retaining screw
27. Pump beam dump

Figure 3-2. Laser Head Controls – Cover Off

Table 3-2. Laser Head Controls – Cover Off

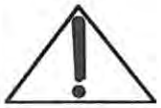
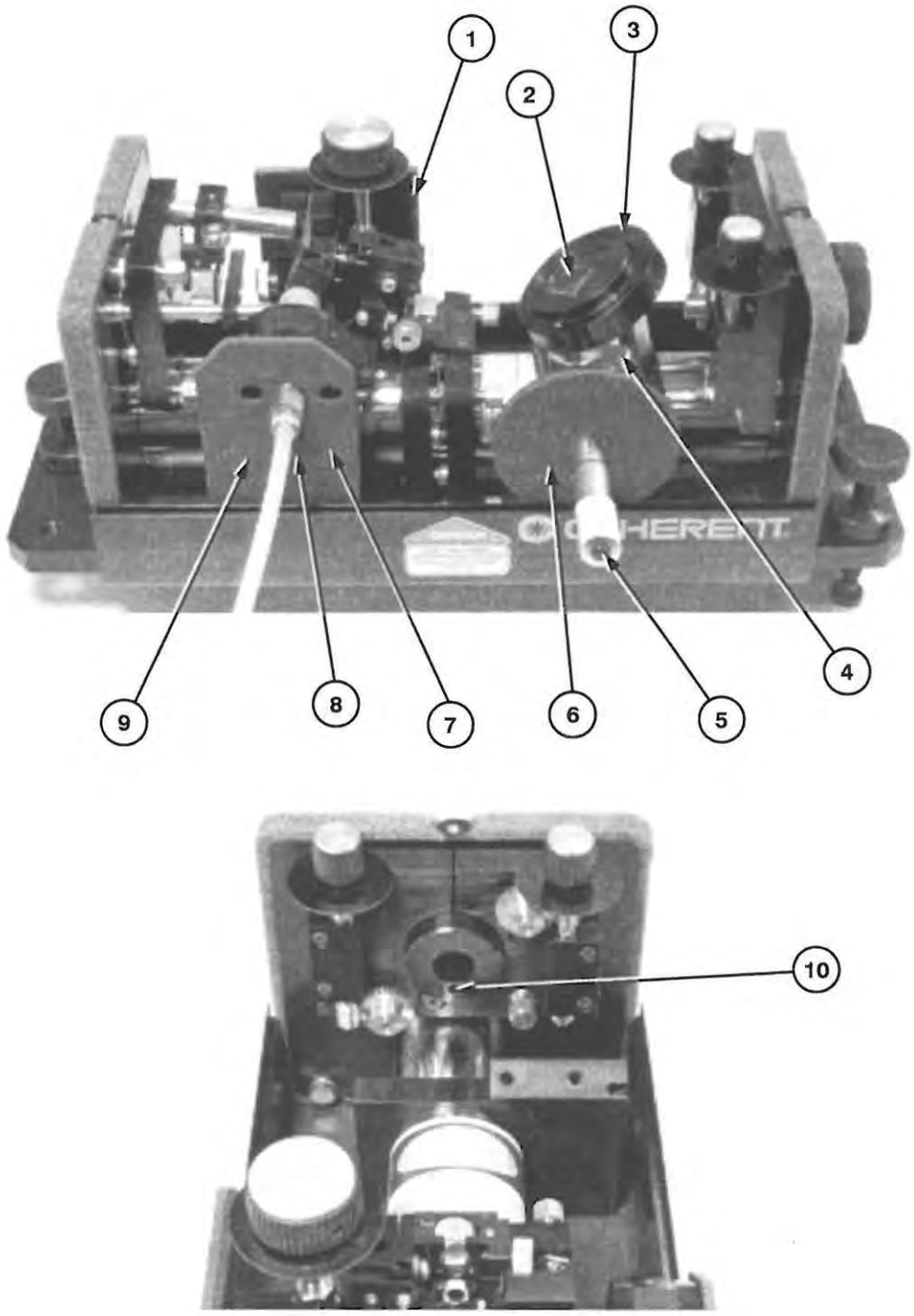
ITEM	CONTROL	FUNCTION
1	M2 mount assembly pivot adjust	This adjustment establishes the pivot position about which the M2 mounting plate horizontal and vertical tilt angle adjustments are made. Refer to item 25 below.
2	Pump mirror alignment hole	The pump beam is steered into this alignment hole by the pump mirror during the full alignment procedure. This establishes the initial positioning of the pump beam which becomes a reference for jet alignment.
3	M2 mount assembly adjust	Allows removal of the M2 mount assembly during alignment. Allows repositioning during alignment/dye change. Since different dyes can use a different M2 optic with a different radius, the position of M2 is used to optimize the beam waist diameter and power density in the dye jet stream. Retains the alignment position when tightened.  **The pump beam (when >150 mW) should not be allowed to strike the M2 mount assembly or the M2 optic to prevent possible damage to the optic and to achieve stable operation. The pump beam dump should always be in place when the pump beam exceeds 150 mW.** **A water cooled beam dump should be installed when the pump power is greater than 10 Watts.**
4	M2 optic mount assembly retaining screw	Loosening this screw and removing the optic retainer allows the M2 optic to be removed.
5	Fold mirror M2	Cavity fold mirror.
6	Catch tube retaining screw	Secures the catch tube in place.
7	Catch tube pump beam cutout	This cutout allows the pump beam to pass through while intersecting with the dye jet stream.
8	Neutral density filter	Allows the intersection of the dye jet stream and the pump beam to be viewed during alignment.
9	P1 focus adjust	Adjusts pump beam focusing at the dye jet stream. After a focus change, the pump mirror horizontal and vertical translation adjust knobs should be used to fine adjust the pump beam position in the dye jet (fine compensation of the pump beam waist translation to better overlap with the cavity beam waist.
10	P1 coarse horizontal angle adjust	Loosening this screw allows coarse horizontal angular adjustment of the pump mirror assembly during full alignment.
11	P1 mount rotational and vertical adjust	As noted in item 2 above, the pump beam is steered into the alignment aperture. Loosening this screw allows manual positioning of the pump mirror mount along the vertical axis, allows rotational adjustment about a horizontal axis, and secures the pump mirror mount after adjustment.
12	Pump mirror P1	Steers and focuses the incoming pump beam to intersect with the dye jet stream.

Table 3-2. Laser Head Controls – Cover Off (Continued)

ITEM	CONTROL	FUNCTION
13	P1 retaining screw	Secures the P1 optic in the optic mount assembly. Refer to Chapter Seven, Maintenance, for P1 removal procedures.
14	End mirror M1	High reflector end mirror in the 3-mirror cavity.
15	M1 optic retaining screw	Secures the M1 optic in the optic mount assembly.
16, 18	M1 horizontal and vertical tilt angle adjust	Allows horizontal and vertical tilt angle adjustment of the fluorescent spot during alignment and optimization.
17	M1 mount assembly pivot adjust	This adjustment establishes the pivot position about which the M1 mounting plate horizontal and vertical tilt angle adjustments are made.
19	Dye jet stream boot	Catches dye drips from the nozzle when the dye jet is turned off.
20	Jet translation assembly locking screw (2)	when loosened, allows jet translation assembly adjustments. When tightened, secures all jet translation assembly adjustments. Jet translation assembly adjustments facilitate the dye jet stream adjustments described in Table 3-4.
21	Jet translation assembly securing screw	Secures the jet translation assembly in place.
22	Dye input hose locking nut	Secures the 1/8 in. (ID), 1/4 in. (OD) plastic tubing that transports dye from the dye circulator to the dye jet nozzle.
23	Dye input hose	Routes pressurized dye from the dye circulator to the dye jet nozzle.
24	Jet translation assembly	Allows positioning of the dye jet stream in the catch tube. Allows centering the dye jet stream on the pump beam. Refer to Table 3-5 for jet translation assembly adjustments. Secures the dye jet nozzle at Brewster's angle with respect to the pump beam.
25	M2 horizontal and vertical tilt angle adjust	Allows horizontal and vertical tilt angle adjustment of the fluorescent spot from M2 during alignment and optimization.
26	Pump beam dump retaining screw	Secures the beam dump in place.  **This screw must be loosened prior to repositioning the beam dump. Failure to do so may eventually loosen the beam dump mounting rod which could cause instability in the cavity.**
27	Pump beam dump	Dissipates the energy of the residual pump beam. This avoids adverse performance due to heat buildup on M2 or the M2 mount. Additionally, the passive beam dump must be replaced with a water cooled beam dump when using a pump laser generating 10 or more Watts. Refer to XXXXXX for additional information on the water cooled beam dump.

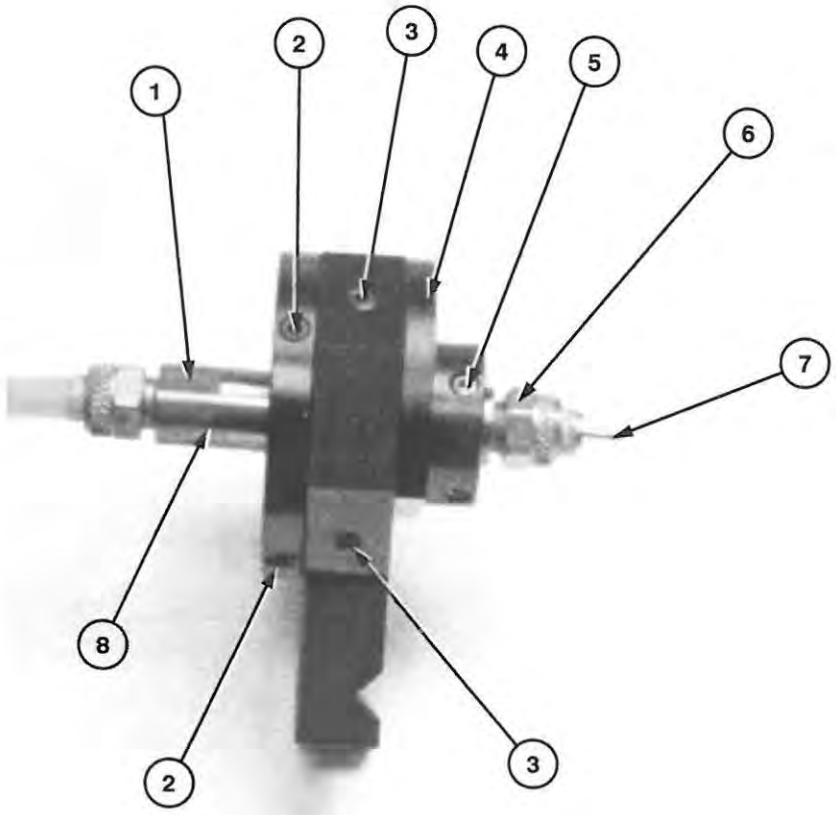


1. Light shield, catch tube
2. Birefringent filter (BRF) optic
3. BRF assembly
4. BRF retaining screw
5. BRF micrometer
6. Light shield, BRF assembly
7. Light shield, translation assembly
8. Light shield retaining screw
9. Cooling water lines location
10. Pump beam alignment aperture

Figure 3-3. Laser Head Controls – Cover Off

Table 3-3. Laser Head Controls – Cover Off

ITEM	CONTROL	FUNCTION
1, 6, 7	Light shields	Prevents laser light leaks from the laser head cover openings for the external controls.
2	Birefringent filter (BRF) optic	Quartz crystal positioned at Brewster's angle in the cavity that allows tuning the laser. Refer to XXXXX for additional information on BRF tuning.
3	BRF assembly	Allows tuning the laser cavity as described under item 5. The BRF assembly consists of the BRF crystal and holder, retaining ring, and micrometer assembly as shown on Figure 7-6.
4	BRF retaining screw	Secures the BRF to its mount. Allows removal of the BRF assembly.
5	BRF micrometer	Using the factory calibration sheets supplied with the laser, the micrometer can be used to tune the laser to any wavelength within the dye tuning range.
8	Light shield retaining screw	Secures the light shield in place. Allows removal of the light shield.
9	Cooling water lines location	The arrows show the approximate location when the cooling water lines enter and exit the laser head. Cooling water is used only when pumping the dye laser with 10 or more Watts. In this case, a water cooled beam dump must be installed. The exact location can be determined by removing the jet translation assembly light shield. Refer to XXXXX for additional information on the water cooled beam dump.
10	Pump beam alignment aperture	Used to align the dye laser to the incoming pump beam during installation or full alignment.

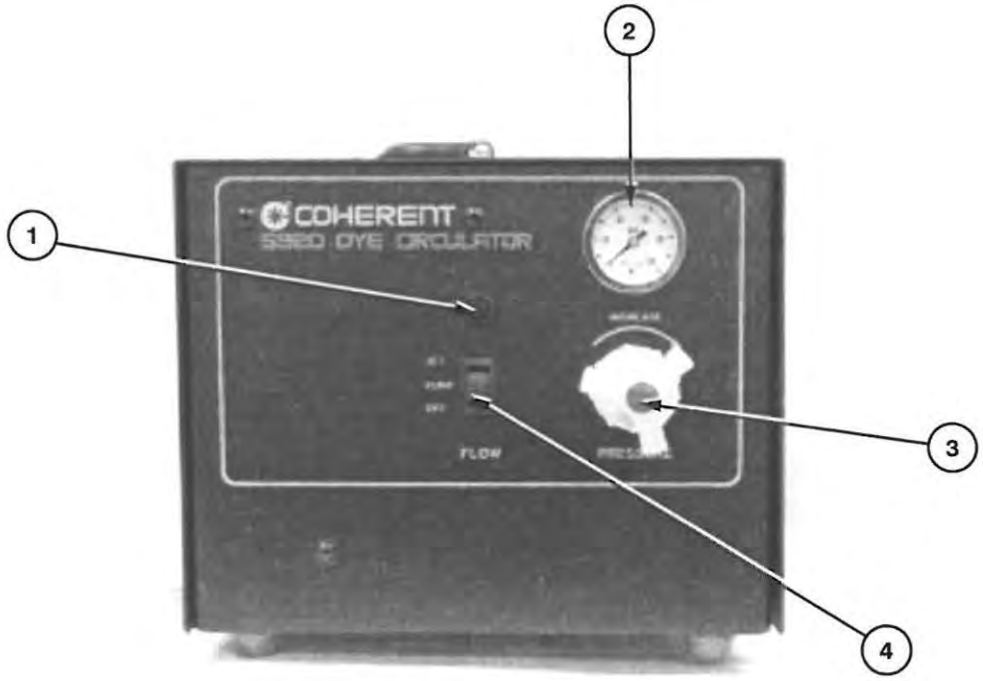


1. Machined flat
2. Jet pointing adjust (4)
3. Jet translation adjust (4)
4. Retaining plate
5. Jet pivot (4)
6. Jet nozzle locking nut
7. Jet nozzle
8. Jet holder

Figure 3-4. Dye Jet Translation Assembly

Table 3-4. Dye Jet Translation Assembly

ITEM	CONTROL	FUNCTION
1	Machined flat	A 3/8" open end wrench fits onto the machined flat surface to hold the dye jet nozzle in place while removing or installing the dye input hose locking nut (Figure 3-2, item 21). This flat is also used when loosening or tightening the nut securing the dye jet nozzle. This flat is also used when adjusting the dye jet nozzle to Brewster's angle.
2	Jet pointing adjust (4)	Together with the jet pivot adjust (item 5) and the jet translation adjust (item 3), allows adjustment of the dye jet stream in the catch tube.
3	Jet translation adjust (4)	Adjusts the dye jet stream along the horizontal and vertical axis to facilitate adjustment of the dye jet stream to the catch tube.
4	Retaining plate	The locking screws (Figure 3-2, item 20) screw into this plate and holds the jet translation assembly together while retaining all adjustments made to the jet translation assembly.
5	Jet pivot (4)	Functions as a pivot for adjustments made with the "jet pointing adjust", item 2. Refer to Figure 3-4.
6	Jet nozzle locking nut	Secures the jet nozzle in place.
7	Jet nozzle	Creates a flat optical quality surface (dye jet stream) that intersects the pump beam at Brewster's angle.
8	Jet holder	Holds the dye jet nozzle at Brewster's angle. Refer to item 1 for additional information.



Front Panel

Rear Panel

1. On/Off indicator
2. Pressure indicator
3. PRESSURE regulator knob
4. FLOW switch
5. JET RETURN connector
6. 115/230 AC switch
7. Fuse
8. Power cord
9. JET SUPPLY connector
10. Cover thumbscrews (4)
11. WATER OUT connector
12. WATER IN connector

Figure 3-5. Dye Circulator Controls

Table 3-5. Dye Circulator Controls

ITEM	CONTROL	FUNCTION
Front Panel		
1	On/Off indicator	Lights when FLOW switch is in the PUMP or JET position. Refer to Figure 6-2 for a schematic diagram of the dye circulator showing the paths for the PUMP and DYE positions.
2	Pressure indicator	Indicates dye pressure in psi.
3	PRESSURE regulator knob	Controls dye pressure when the FLOW switch is in either the PUMP or JET position. Refer to Chapter Three, Daily Operation, or Chapter Five, Installation and Alignment, for proper dye pressure adjustment.
4	FLOW switch	Controls operation (On, Off, PUMP, JET) of the dye circulator pump and controls circulation of dye through the laser head jet. Refer to Figure 6-2 for a schematic diagram of the dye circulator showing the paths for the PUMP and DYE positions.
	PUMP position	The dye will loop within the dye circulator as shown in Figure 6-2 but will not flow through the laser head in this position. This position should be used for a few seconds before setting the FLOW switch to JET. This allows dye cooling and eliminates bubbles. The PUMP position can be used to check for leaks and as an interim position to adjust the PRESSURE knob before setting the FLOW switch to JET.
	JET position	Allows dye to flow through the laser head.
	OFF position	Turns off the dye circulator. Setting the FLOW switch to any other position turns the dye circulator On.
Rear Panel		
5	JET RETURN connector	Provides for connecting 1/2" (ID), 5/8" (OD) plastic tubing that provides a dye return path from the laser head to the dye circulator resorvoir.
6	115/230 AC switch	Allows 115 or 230 Volt AC operation. Position is set during installation only. Refer to Chapter Five, Installation and Alignment, for information on 230 VAC operation.
7	Fuse	3 Amp dye circulator fuse for either 115 or 230 VAC operation.
8	Power cord	Plugs into 120 VAC facility power outlet. Refer to Chapter Five, Installation and Alignment, for information on 230 VAC operation.
9	JET SUPPLY connector	Provides for connecting 1/8" (ID), 1/4" (OD) plastic tubing that supplies pressurized dye from the dye circulator to the laser head.
10	Cover thumbscrews	Four thumbscrews allow cover removal and secures the cover in place.
11	WATER OUT connector	Provides for connecting 5/32" (ID) plastic tubing for the cooling water supply return. Refer to Chapter Five, Installation and Alignment for additional information on disposition of cooling water.
12	WATER IN connector	Provides for connecting 5/32" (ID) plastic tubing for the input cooling water supply from a facility source or from a separate water conditioner. Refer to Chapter Five, Installation and Alignment for information on cooling water requirements.

OPERATOR'S MANUAL

CHAPTER FOUR
DAILY OPERATION

COHERENT®

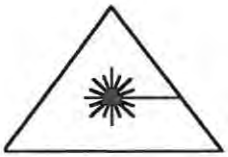
Introduction

It is assumed that the safety information in the ion pump laser operator's manual has been read and understood prior to operating the 599 dye laser.

Tuning curves that represent typical operating characterics (output power as a function of wavelength for a given dye) are located in Appendix A.

Turn-On Procedure

The following procedures assume that the pump laser and the dye laser have been installed in accordance with Chapter Five, Installation and Alignment, and that the dye circulator contains dye solution.



Ensure all personnel in the area are wearing laser safety glasses appropriate for the wavelengths and power levels produced by the ion pump laser and the 599 dye laser.

The dye laser and the pump laser are designed for operation with the protective covers in place. Operation with the protective covers removed will allow access to hazardous visible and invisible radiation which may exit at unpredictable angles from the laser head.

ION PUMP LASER:

It is assumed that the ion pump laser to be operating in accordance with all pump laser specifications. Refer to the ion pump laser operator's manuals for operation of the pump laser. For convenience, a summary of the necessary steps are listed below:

- Block the pump beam output and turn on the ion laser.
- Adjust the ion laser for the specified output which is summarized in Table 2-3 for each dye. Ensure the mode is good. It is recommended that power track be used.
- It is further recommended that the ion laser is allowed to reach thermal equilibrium before any adjustments are made.

DYE LASER

1. Turn on dye circulator cooling water.

2. Ensure the pump laser is turned on as described in the preceding paragraph.

3. Set the FLOW switch on the dye circulator to the PUMP position. The on/off indicator should light.

   a. Allow pressure to stabilize.

   b. Switch to JET position. Pressure should be approximately 40 psi.

   c. Check for any signs of leaks or bubbles.

   d. If bubbles are detected, reduce the pressure in increments of 10 psi until the bubbles stop.

   e. If bubbles continue, refer to the section titled, "Troubleshooting" located in Chapter Seven.

4. Allow the pump beam to strike the jet.

5. Wait for 5 to 10 minutes for the dye laser to thermally stabilize.

6. If the system is lasing, peak the pump controls and output coupler for power. If the system does not lase, refer to "Troubleshooting".

7. Inspect the system for cleanliness. If necessary, clean optics.

8. If power is below specifications, refer to "Troubleshooting".

The dye laser is now ready for use.

Turn-Off Procedure

1. Turn off the pump laser.

   If the turn-off is temporary, the pump laser should be left on. In this case, the laser can be switched to low power and the output beam can be blocked.

2. Note the pressure on the dye circulator pressure indicator. Set the FLOW switch on the dye circulator to OFF.

OPERATOR'S MANUAL

CHAPTER FIVE
INSTALLATION

COHERENT®

Introduction

This chapter contains installation procedures including an abbreviated alignment procedure.

Utility Requirements

Table 5-1. Utility Requirements

PARAMETER	REQUIREMENT
Electrical:	
Dye laser	None
Dye circulator	115 VAC, 60 Hz, 3A, single phase, or 240 VAC, 50 Hz, 1.5A, single phase optional.
Pump laser	Refer to the pump lasers' operator's manual.
Water:(1)	
Dye circulator:(2)	6.5 °C to 14 °C (44 °F to 57°F) inlet temperature.
Dye laser:	No cooling is required for pump lasers under 10 Watts. When pumped by 10 Watts or more, cooling water is required. In addition, a water cooled beam dump must be installed in the dye laser. Refer to the paragraph titled, XXXXXXXXXXX, located in this chapter.
Pump laser	Refer to the pump lasers' operator's manual.
Environmental:	
Pump laser	Refer to the pump lasers' operator's manual.
N2 purge	

(1) Check local and state regulation which may control use of city water for cooling. Some regulatory codes will not allow the discharge of cooling water into the sewer system.

(2) Certain dyes may have optimum operating temperatures. Refer to Appendix A for additional information on dye temperatures.

Installation Equipment

Table 5-2. Equipment Required/Recommended for Installation, Alignment, and Operation

EQUIPMENT	QUANTITY	USE
REQUIRED		
Dye laser tool kit	1	Contains wrenches and balldrivers necessary to install and align the dye laser.
Dye prepartion materials:		
Mixing containers	3	Mixing dye solutions.
Eye dropper(s)	As required	Used for adding small amounts of dye to the dye circulator
Rubber gloves	As required	Protects hands from toxic chemicals
Ethylene glycol	As required	Part of dye solutions
Toxic chemical disposal containers	As required	Used for disposal of dye and dye contaminated materials such as towel, etc. Containers must be in accordance with local codes.
Graduate	As required	Used for mixing dyes
Optics cleaning:		
Hemostats	1	Optics cleaning
Lens tissue	As required	Optics cleaning
Methanol, reagent grade) and/or actone	As required	Optics cleaning. For convience and ease of use, methanol/acetone should be kept in small dispensing containers.
Diverging lens or mirror (3-10 cm focal length with 3 mm clear aperture minimum)	1	Used for checking beam mode. Not supplied with system.
Power meter	1	Checks output power. A Coherent Model 210 is recommended.
RECOMMENDED		
Foot clamps	3	Retains the position of the laser after the laser has been aligned to the pump laser. Foot clamps are highly recommended since dye laser/pump laser misalignment can adversely affect laser performance.

Table 5-2. Equipment Required/Recommended for Installation, Alignment, and Operation (Continued)

EQUIPMENT	QUANTITY	USE
RECOMMENDED (Continued)		
Optical table	1	Reduces or eliminates mechanical vibrations that adversely affect laser performance parameters (including optical noise and pointing stability).
Hood	1	Mixing dye.
Agitator	1	Mixing dye.

Pump Laser

The pump laser requirements vary with the dye to be used. The pump laser must operate in accordance with specification and in a good TEMoo mode at all times. Refer to Table 2-3 for pump laser recommendations.

Install the pump laser in accordance with the pump laser operator's manual.

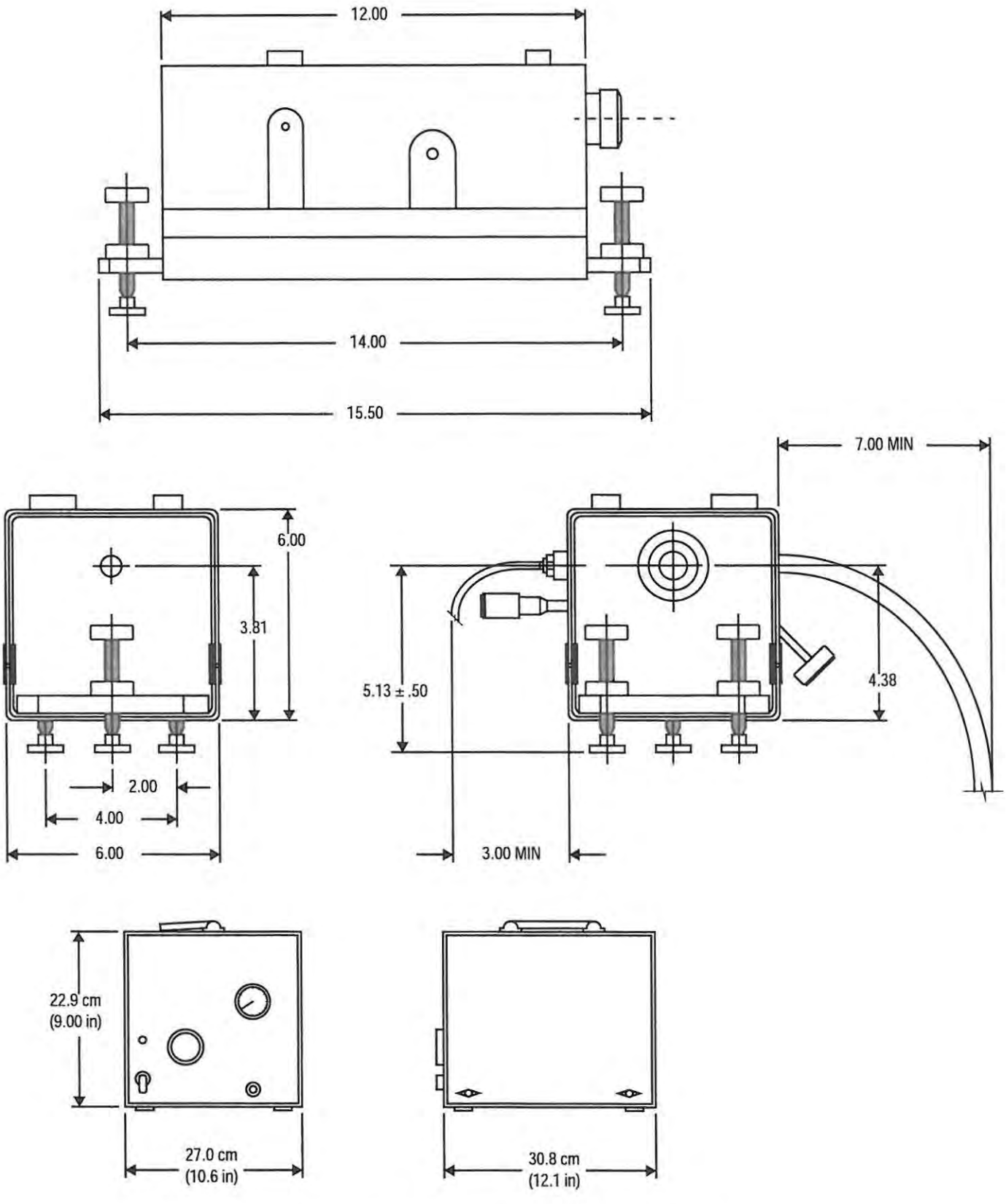


Figure 5-1. Dye Laser and Dye Circulator Dimensions

Unpacking and Installation

Uncrating

To prevent unnecessary damage to the shipping crates during unpacking, the covers are secured with reusable clips. After the laser and accessories have been removed, it is strongly recommended that all packing materials be replaced, the covers refastened and the crates stored for future use.

Dye Circulator

Unpacking

Removed the dye circulator from the shipping container and inspecting it for damage.

1. Remove the shipping screws from the bottom of the dye circulator (Figure 5-X). This frees the pump support from the main chassis to de-couple pump vibration from the hose line connections to the dye laser.

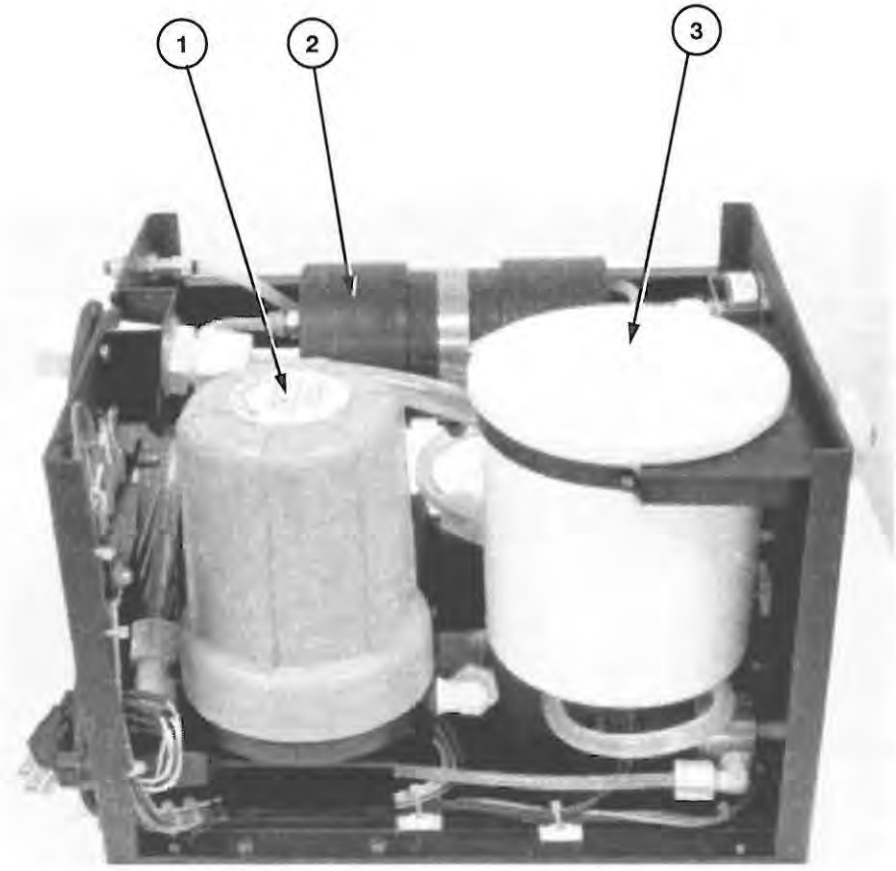
To prevent damage to floor surfaces caused by inadverdent leakage of dye from the dye circulator, the dye circulator can be placed in a flat-bottomed container 5-10 cm (2 to4 in.) deep.

2. When the dye circulator is picked up by the chassis, the pump support mounts will center themselves in their clearance hole in the chassis. Upon placing the dye circulator in its location, contact between pump and chassis will be eliminated.

Installation

1. Remove the cover from the dye circulator by loosening the four thumb screws on the sides and lifting. Refer to Figure 3-X for the location of dye circulator components.

2. Remove the reservoir cover. Remove the absorptive wadding and discard.



1. Dye filter (filter cartridge inside)
2. Heat exchanger
3. Dye reservoir

Figure 5-2. Dye Circulator Components – Cover Removed

3. Ensure the dye filter housing is tight.

4. Ensure the voltage selector at the rear of the dye circulator is set at the appropriate voltage and connect the dye circulator to an electrical outlet.

5. Turn the PRESSURE regulator knob counterclockwise approximately five turns.

6. Attach the large diameter (1/2") and small diameter (1/4") hoses to the matching connections at the rear of the dye circulator. Fittings should only be finger tight.

7. The dye circulator is now ready to be connected to the dye laser. Connect the 1/4" tubing to the jet feed input.

Place an open-ended wrench on the machined area of the jet holder to prevent accidental movement of the nozzle.

8. Connect the return hose to the laser by loosening the 9/64" hex screw inside the laser head (Fig. XXX). The hose may have to be cut to ensure a proper return path. A minimum of 5% downward slope is needed to eliminate any back up of fluid in the hose.

   Slide the return hose into the opening on the foam shielding on the side of the laser. Make sure the return hose slides over the stainless steel catch tube. Once the tubing is in place, tighten the 9/64" hex screw. This will secure the hose and eliminate the possibility of dye leakage. Connect the cooling lines to the rear of the circulator. Turn on the water and note the temperature drop in the head exchanger.

9. Ensure that the water temperature is 6.5 to 14°C (45 to 60°F). If the water temperature is outside of these parameters, consult Coherent Customer Service.

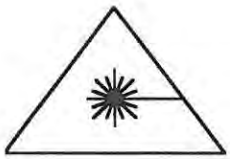
   Connect the cooling-water lines to the back of the dye circulator, turn the water on and check for leaks.

10. Refer to Chapter Seven for a description of dyes and dye recipes.

    Add 400 to 400 ml of base solution to the reservoir. Switch the module on and check for leaks in the dye circulator. Adjust the pressure to 20 psi. If leaks occur, switch off the dye circulator, clean the spill and locate the source of the leak. Close the splash shield (Fig. XXX) over the opening of the catch tube by sliding the splash shield along the catch tube assembly until it stops to prevent dye from splashing onto optics. Once the bubbles are out of the lines, adjust pressure to 40 psi.

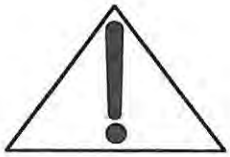
Dye Laser Installation

The procedure given in this chapter ordinarily will be sufficient to obtain satisfactory performance from the dye laser since it is unlikely that the factory aligned mirrors and jet have been misaligned during shipping.



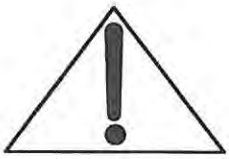
The pump laser output should be blocked unless the dye is flowing through the jet. Do not allow the pump beam to enter the dye laser if the jet is off and the fold mirror is in place as this could result in permanent damage to the fold mirror optic.

If this procedure fails to achieve lasing, perform the full alignment procedures located in Chapter Seven.



Before placing the dye laser in front of the ion (pump) laser, ensure that the beam from the ion laser is parallel to the surface of the table.

1. Place the dye laser head about one foot in front of the pump laser. Both the pumping laser and the dye laser should be mounted on the same platform or table.



Any relative motion between ion laser pump and dye laser will adversely affect performance. After the dye laser is lasing, a test for insufficiently rigid mounting can be made by tapping on the table to see if the dye laser output power fluctuates.

2. Remove the cover from the dye laser head. Inspect for damage. There are four types of controls:

3. There are eight (8) laser mirror adjustments for the three mirrors that make up the optical cavity. Only the output mirror has controls accessible through the cover, and normally would be the only mirror requiring adjustment.

4. With a freshly mixed dye solution on hand,

5. Attach the dye circulator hoses to the laser head.

The dye laser has been aligned at the factory. The procedure below will suffice to line up the dye laser with the pump laser and correct for minor misalignment. A complete alignment procedure is located in Chapter Seven.

Finding the Fluorescent Spots

If you are unable to find the output fluorescent spots, proceed as follows.

Place a piece of paper inside the cavity just in front of the birefringent filter. You should be able to find one or two bright yellow spots. You will see one spot if the two spherical mirrors are aligned properly (e.g., colinearly). You will see two spots if they are not aligned properly. If you see two non-overlapping spots, adjust the High Reflector radius mirror by means of its mirror mount adjustment screws (fig. XXX) until the two spots overlap.

OPERATOR'S MANUAL

CHAPTER SIX
THEORY

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Optical System

The basic design of the Model 599 Standing Wave Dye Laser is a three-mirror, non-colinearly pumped, astigmatically compensated cavity. The pump beam is focused onto the dye stream by the pump mirror, P1. The dye stream consists of a high viscosity solvent (usually ethylene glycol) with an organic dye solution at a concentration of 10^{-4} to 10^{-3} molar. Cooling the dye mixture increases its viscosity which leads to a more stable stream.

The dye laser TEM_{00} mode diameter of the jet is about 23 μm for the long radius case and about 7 μm for the short radius case. The pump mirror focus adjustment has sufficient range for matching between pump and dye laser modes in all cases.

The end mirror M1 has a 5 cm radius. The output mirror M3 is flat. Typically, the maximum output coupling is 2 to 5%. The 599 dye laser achieves high performance over a large wavelength range.

Jet Stream Technology

The 599 dye laser uses a flat parallel jet of dye dissolved in a high viscosity solvent (such as ethylene glycol) in a typical concentration of 3×10^{-3} molar. Dyes with higher thresholds can be successfully used with the 599 dye laser.

Birefringent Filter Tuning Element

The 3-plate birefringent filter tuning element consists of three flat and parallel crystalline quartz plates placed inside the dye laser cavity at Brewster's angle. The plates form a birefringent filter which has low loss for linearly polarized light at a particular wavelength. There is another transmission order approximately 1000 Å away so that a dye that oscillates over a 700 Å range, for example, will see only one of these transmission orders for a particular filter orientation.

The plates are oriented so that the optical axis of each crystal is in the plane of the face and the axis of all the crystals are parallel to each other. They function as full wave plates and as the plates are rotated about a surface normal, the low loss wavelength changes because the effective extraordinary index of refraction changes. Thus, the laser output wavelength is tuned.

This method of tuning is superior to tuning with an intracavity prism since the filter, rather than the cavity alignment, determines the wavelength. Insertion of the tuning element typically reduces the output power by 5 to 10%.

Birefringent Filter Tuning Orders

The purpose of the BRF is to provide system tuning (wavelength selection) capability. The fundamental operation of the BRF uses a property of the quartz crystal. The name itself, birefringent, is indicative of the properties of the crystal. This means that the crystal will have two different refractive indices for the two orthogonal components of the polarized beam.

The 3-plate birefringent filter, which has a periodic filter function, is an effective tuning element for a CW tunable laser. However, because of the makeup of the filter (mainly the overlap of the tuning order of the three plates, Figure 6-1), and the large variations in gains and losses encountered over a given tuning range, some dye optic sets may exhibit jumpbacks in wavelengths especially at the ends of their tuning curves. This jumpback phenomenon occurs when the gain in an adjacent BRF order becomes equal to the gain in the operating BRF order. The exact wavelength of this jumpback will depend on alignment, pump power, cavity configuration, and wavelength. This explains why some tuning curves seem to end when there still appears to be ample power to continue tuning. This problem can often be alleviated by the installation of a high reflector from an adjacent optics set (most conveniently the upper fold mirror) which changes the losses in the cavity to shift or prevent these jumpbacks. For instance, LD700 at approximately 785 nm can exhibit a jumpback to approximately 700 nm. As illustrated on Figure 6-1, there is an overlap of tuning orders of the filter in this wavelength region so that the same wavelength can be obtained with two positions of the BRF. Since there is more

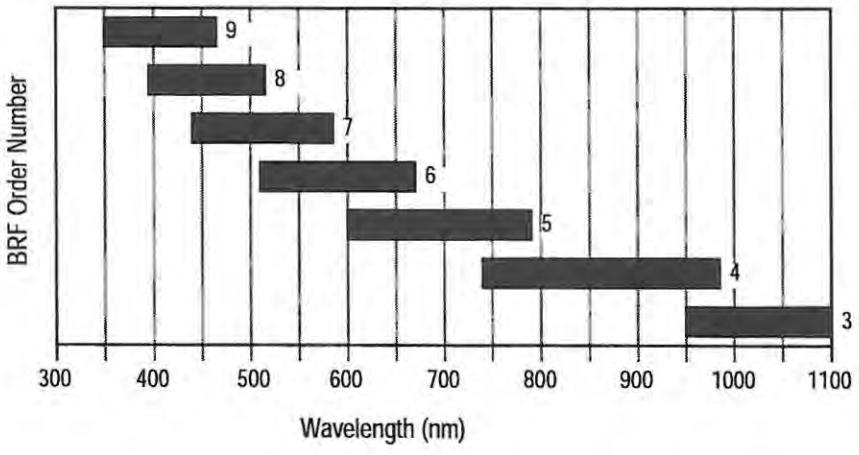


Figure 6-1. Birefringent Orders in the Laser Cavity

gain in the dye at 700 nm, this laser will preferentially operate at the shorter wavelength. In this case, the upper fold HR from the next bluer optics set was installed to prevent jumpback to a longer wavelength, thus extending the blue end of the tuning curve. This effect can also be seen at the blue end of tuning curves such as R110.

There is, for most dyes, one BRF tuning order that will always give superior power and tuning performance over the adjacent BRF orders. Make sure the laser is operating on the right BRF order for best performance.

The BRF "filter stack" is glued into a holder which has a slot in its side to allow repeatability when removed and reinstalled. This holder slides into a securing ring and is held in place with one set screw. It may be slid in and out as required by the system alignment. The securing ring in turn fits onto the micrometer frame and is held by one screw. This securing ring has three holes through which the screw can go. The hole used in manufacturing (and hence that will correlate with the calibration data shipped with the system) is the uppermost hole. Refer to Figure 7-6.

The Dye Circulator

Dye flow is maintained by the dye circulator. The functional elements of the circulator are shown in Figure 6-2. The main volume of dye solution is held in a reservoir, while a positive displacement pump is used to force the dye solution through the outlet hose and out of the dye jet nozzle. A return hose catches the dye jet stream and conducts the dye solution back into the reservoir.

As the pump operates, it introduces heat into the dye solution which, unless removed, will elevate the dye temperature and degrade laser performance. The dye circulator includes a heat exchanger to permit water cooling of the dye. This is essential for operation of a high precision dye laser. In most applications, laser performance will be noticeably enhanced by cooling the dye to approximately 4° C.

It is recommended that the dye be cooled between 1-14°C (45-60°F) for best performance. Refer to the dye fact sheets in Appendix A for additional information on dye temperatures. Some dyes, such as Coumarin 30 may fall out of solution if cooled below 15° C. An external heat exchanger can be used if problems with dye temperature are experienced. The temperature should never exceed 20°C (72°F).

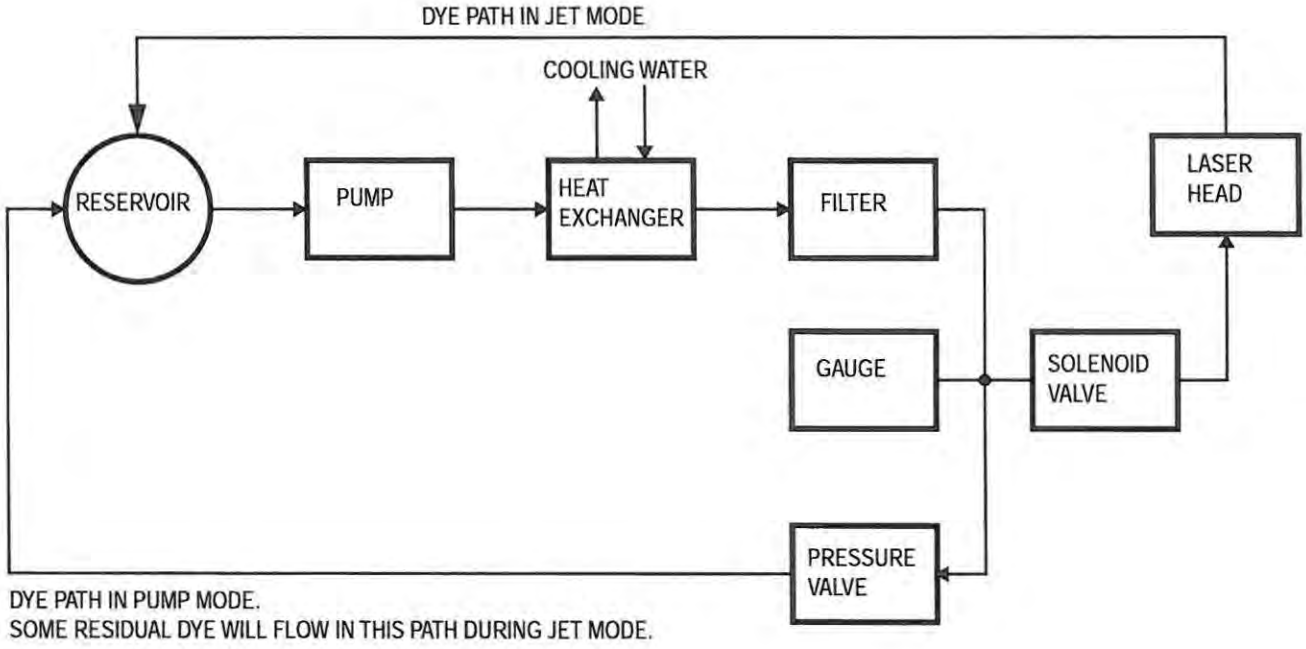


Figure 6-2. Dye Circulator Block Diagram

Dyes and Solvents

The jet stream dye laser design requires that the solvent (transport agent) have sufficient viscosity to maintain an optically flat stream of dye. Most commercially available dye lasers use ethylene glycol as a solvent base because of its viscosity as well as its optical and thermal properties.

Since many dyes do not readily dissolve in ethylene glycol, a premix may be required. Premixing with a separate solvent such as methanol or benzyl alcohol helps in the mixing process.

Refer to Chapter Seven, Maintenance, and Appendix A, Tuning Curves, for dye mixing procedures, premix, solvents, absorption, and other recommendations.

There is an optimum dye concentration for a given dye gain and is generally between 75% and 80% absorption of the pump beam. Refer to Appendix A, Tuning Curves, for the absorption for a given dye. The optimization of the dye concentration is accomplished by adding the premix in small increments to the solvent in the dye circulator until approximately 80% absorption is achieved (or until there is no further increase in output power).

Contamination of the dye by dyes of longer wavelengths causes serious optical gain losses due to absorption of the fluorescence. It is therefore necessary to thoroughly clean the dye circulator and install a new filter when switching to a shorter wavelength dye (or when replenishing an expended dye).

All dyes degrade during operation, primarily due to the breaking of molecular bonds. The lifetime of the dye is given in watt-hours of pump power; it is measured when the power has degraded to 75% of the power available with fresh dye. Some dyes have very short lifetimes (Coumarin 30, approximately 100 watt-hours), while others have very long lifetimes (Rhodamine 6G, approximately 1000 watt-hours).

The exact toxicity of laser dyes is not well known, but they should, like all chemicals, be considered dangerous until proven otherwise. The safest precaution is to use rubber gloves and a mask, and work only under a fume hood when preparing the dye solution. Clean any skin that comes in contact with the dye solution or the dye itself. Solvents should be kept away from heat, sparks, and open flames, since they are flammable.

OPERATOR'S MANUAL

CHAPTER SEVEN
MAINTENANCE

COHERENT

Cleaning Optics

In order to maintain optimum performance from high-grade optics, proper cleaning is an absolute necessity. Laser optical components are routinely exposed to high energy levels. When optical coatings are clean, this energy will either be reflected or transmitted. Contaminants on the surface of the optic absorb energy, creating hot-spots which can burn the precision coating and dramatically reduce laser efficiency. Absorption caused by contaminated optical surfaces will degrade performance and shorten mirror life.

Contaminants which can cause absorption include a variety of particles which may fall on the optical surface or condense from surrounding vapors. Even lens tissue fibers, and plastic gloves can be a source of contaminants.

Before cleaning optics, make sure your hands are clean and that a clean, cushioned work surface is available.

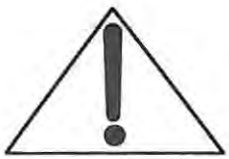
Cleaning optical surfaces too often increases the possibility of scratching mirror surfaces and therefore may shorten the useful life. Keep the laser head cover closed to prevent contamination of the cavity optics, and store optics not currently being used in sealed containers.

Optics cleaning is not required as part of regular maintenance. Optics should be cleaned as corrective action for marked power decrease or poor mode quality.

Table 7-1 provides a summary of optics cleaning recommendations.

Cleaning Installed Optics

When possible, clean the optic while it is installed to minimize disturbing the optical alignment. Refer to Table 7-1 for specific recommendations.



A special method is used to clean the birefringent filter and is located in the section titled, Cleaning the Birefringent Filter. Do not use any other method.

1. To access an installed optic;

   - Block the pump beam with a power meter or other device (with a power absorbing non-reflecting surface) to prevent it from entering the dye laser cavity.

Table 7-1. Optics Cleaning Summary

OPTIC	RECOMMENDED CLEANING LOCATION	COMMENTS
Pump mirror P1	Clean in place	Removing optic will require full alignment after re-installation of the optic. Refer to the section titled, Pump Mirror Removal and Installation, and to Figure 3-2 for additional information. Only the reflecting surface requires cleaning.
End Mirror M1	Clean in place or remove	Removal and installation in accordance with the procedures in this chapter should not require re-alignment. Only the reflecting surface requires cleaning.
Fold mirror M2	Clean in place or remove	Removal and installation in accordance with the procedures in this chapter should not require re-alignment. Only the reflecting surface requires cleaning.
Output coupler M3	Remove	Both sides of the optic must be cleaned. If the laser has been aligned to a target, following the removal and installation in accordance with the procedures in this chapter can minimize or avoid the need for laser/target re-alignment.
Birefringent filter		**A special method is used to clean the birefringent filter. The cleaning procedure is located in the section titled, "Cleaning the Birefringent Filter". Do not use any other method.**
Refer to the section titled "Optics and Components Removal and Installation" if removing an optic for cleaning.		

Figure 7-1. Cleaning an Installed Optic

- Set the FLOW switch on the dye circulator to OFF.
- Remove the two screws (Figure 3-1, item 2) securing the laser head cover.

2. Neatly fold a sheet of lens tissue into a rectangular shape (approximately 1/4" x 3/4"). Do not contaminate tissue with soiled or oily fingers.
3. Clamp and hold the tissue with hemostats as shown on Figure 7-1. To avoid damage to an optic, ensure the hemostats are not close to the edge of the tissue.
4. Moisten the tissue with reagent grade methanol or acetone. Shake off the excess.
5. Gently wipe across the optic in one direction. One pass should be sufficient. Repeat with a clean tissue if necessary. Performing a second pass with the same tissue can result in damage to the optic surface.

Cleaning Removed Optics

The following technique is recommended for an optic that has been removed from the laser. When possible, clean optics in place to minimize disturbing the optical alignment. Refer to Table 7-1 for specific recommendations. Refer to the section titled "Optics and Components Removal and Installation" for procedures for removing an optic for cleaning.

A special method is used to clean the birefringent filter and is located in the section titled, Cleaning the Birefringent Filter. Do not use any other method.

Optics Inspection

- Remove optic from holder and place the optic on its edge on a clean piece of lens tissue. Do not allow the optic to rest on its polished surface.
- Examine the optic at different light angles for signs of dirt or scratches. If scratches or dirt are present, clean the optic using the cleaning procedures located in this chapter. If the scratches are still present, a new optic will need to be ordered. Refer to Appendix B, Parts List, for the correct part number.
- If no scratches are visible, breathe on the optic. The optic surface should fog with no discoloration. If

discoloration appears, the coating has been damaged and will need replacing. Refer to Appendix B, Parts List, for the correct part number.

- Once the optic inspection has been completed, clean both surfaces of the optic, if required, using the cleaning procedures located in this chapter and replace the optic back into the system.

Cleaning

1. Hold the optic element gently by the edge or place it on a clean work surface covered with lens tissue.

2. Place a few drops of acetone or methanol on one end of the lens tissue. Spectrophotometric or electronic grade is recommended. Handle the optic gently while cleaning it to avoid microfine abrasions. Do not contaminate tissue with soiled or oily fingers.

3. Place the wet end of the lens tissue on the optic and pull it across the optic in one direction only. Do not rub the tissue back and forth. Note that the dry part of the tissue helps remove any acetone residue.

4. Repeat the above steps until the optic is clean, using a new lens tissue for each pass. Reusing tissue may lead to damage of the optic by dragging loose particles back across the surface.

Figure 7-2. Cleaning a Removed Optic

Cleaning the Birefringent Filter

Do not attempt to clean more than the central two-thirds of the birefringent filter (BRF). All of the crystalline quartz plates which make up the birefringent filter tuning element are held in metal mounts by clear cement at four places on their periphery.

The cement is soluble in organic solvents and must not come in contact with cleaning solvent. Also, since the plate edges are not sealed, solvent may get between the plates and form a fog which leads to a large insertion loss in the cavity. Clean the filter only when necessary and follow the procedure below:

1. Perform the "general preparation for removal" procedures located in the preceding section titled, "Optics and Components Removal and Installation".

   To remove the BRF for cleaning, refer to the section titled, "BRF Removal and Installation".

2. Neatly fold a piece of lens tissue into a rectangular shape of approximately 1/4" X 3/4". Do not contaminate the tissue with soiled or oily fingers.

3. Hold the tissue with your fingers or preferably in a pair of hemostats.

4. Moisten the tissue with reagent grade methanol or acetone.

5. Gently wipe across the central two-thirds of the surface in one direction. One pass should be sufficient. Repeat if necessary with a clean tissue. Clean both sides of the optic.

It is possible that after many hours of operation in a dust contaminated environment for dust to accumulate between the plates of a 3-plate BRF. In this case, a decrease in output power will be detected when the BRF is inserted in an optimized cavity. In some cases, scattering of the laser beam can be observed. The BRF can be returned to Coherent if contamination between the plates exists.

Optics and Components Removal and Installation

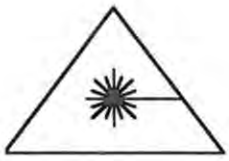
Perform the "general preparation" for removal procedures below prior to removal of optics and components.

General Preparation for Removal

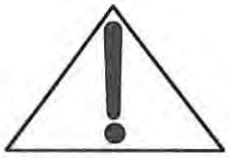
1. Block the pump beam with a power meter or other device (with a power absorbing non-reflecting surface) to prevent it from entering the dye laser cavity.

2. Set the FLOW switch on the dye circulator to OFF.

3. Remove the two screws (Figure 3-1, item 2) securing the laser head cover.



Operating the laser without the protective housing in place exposes the operator to hazardous laser and collateral radiation. Wear safety glasses that protect against the wavelengths employed.



Optics and optic coatings can be easily chipped or scratched. The slightest scratch, trace of dirt or film will severely diminish the laser's efficiency. Before cleaning optics, make sure your hands are thoroughly clean and that a clean, soft, working surface is available. To prevent damage when removing or installing an optic, always grasp the optic by the outer edge - never touch optical surfaces.

On the side of each Coherent optic a small caret (>) is printed. The caret must point toward the gain medium during installation.

End Mirror M1 Removal and Installation

1. Note that M1 can be cleaned in place.

   Perform the "general preparation for removal" procedures located in the preceding section titled, "Optics and Components Removal and Installation".

2. Loosen the M1 mount assembly retaining screw (Figure 7-3, item 1). The M1 mount assembly can now be slightly rotated away from the optic and lifted off the dowel. Remove the M1 optic.

3. Installation is the reverse of removal.

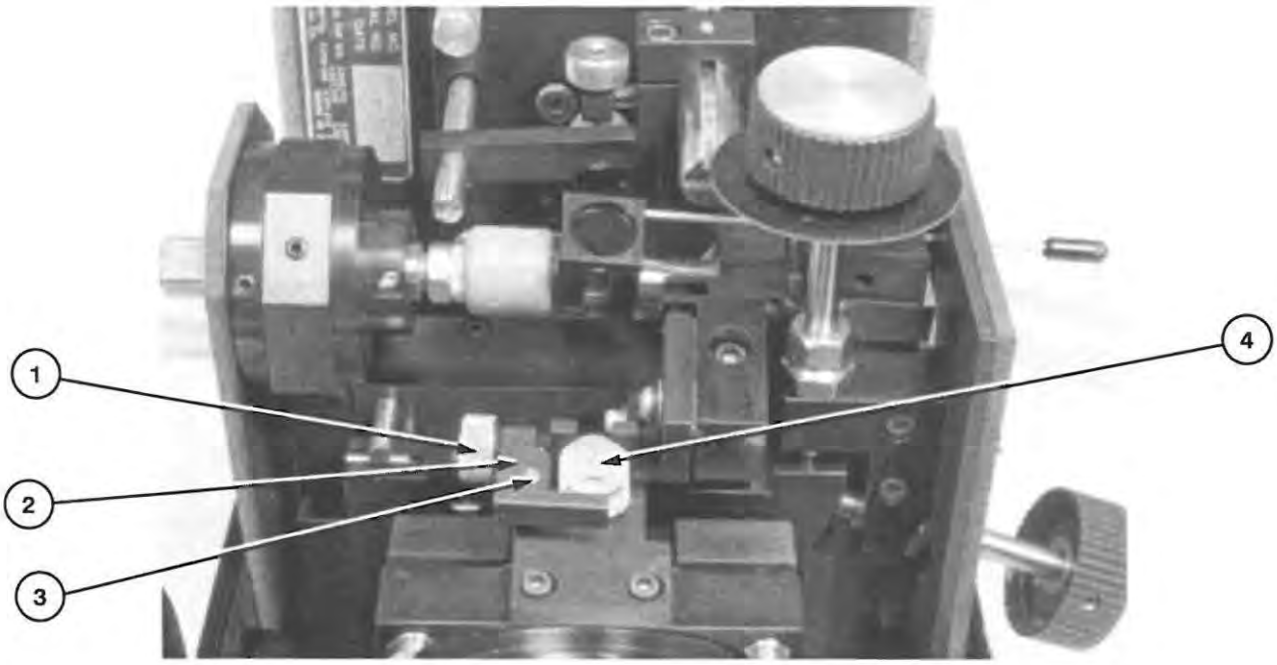
   Ensure the caret (>) on the side of the optic points towards the gain medium (along the beam path).

Fold Mirror M2 Removal and Installation

1. Note that M2 can be cleaned in place.

   Perform the "general preparation for removal" procedures located in the preceding section titled, "Optics and Components Removal and Installation".

2. M2 components are similar to the M1 components shown on Figure 7-3.



1. M1 mount assembly retaining screw
2. M1 mount assembly
3. Dowel
4. M1 optic

Figure 7-3. M1 Optic Removal

If necessary to gain access to M2, the beam dump can be repositioned by loosening the hex head screw (Figure 3-2, item 26) and rotating or sliding the beam dump away from M2.

Loosen the M2 mount assembly retaining screw (Figure 3-2, item 4). The M1 mount assembly can now be slightly rotated and lifted off of the dowel. Remove the M2 optic (item 5).

3. Installation is the reverse of removal.

   Ensure the beam dump is positioned so that the pump beam is not allowed to strike M2 or the M2 mount.

   Ensure the caret (>) on the side of the optic points towards the gain medium (along the beam path).

Output Coupler M3 Removal and Installation

The optic (Figure 7-4, item 1 or 3) can be removed from the holder or adapter for cleaning without disturbing the laser alignment. However, if for example, the laser has been aligned to a target, the optic should be marked (on the side using a pencil) prior to removal so that it can be reinstalled in the same position to minimize or avoid the need to re-align the laser to the target.

1. Perform the "general preparation for removal" procedures located in the preceding section titled, "Optics and Components Removal and Installation".

2. Unscrew the retaining ring (Figure 7-4, item 5) located on the front of the laser. Slide the optic holder (item 2) containing the output coupler from the output aperture.

3. Installation is the reverse of removal. Note the following.

   - The caret (>) on the edge of the optic must always point to the gain medium (along the beam path).

1. Output coupler optic (25.4 mm diameter)
2. Optic holder
3. Output coupler (12.5 mm diameter)
4. Optic adapter
5. Retaining ring

Figure 7-4. Output Coupler M3 Removal

Pump Mirror P1 Removal and Installation

Removing the pump mirror can require a full re-alignment of the laser, therefore; the the optic should be cleaned in place when possible. Some procedures (such as the full alignment procedures) in this manual may require pump mirror removal.

1. Perform the "general preparation for removal" procedures located in the preceding section titled, "Optics and Components Removal and Installation".

There are several methods for removing the pump mirror:

- Method 1. Usually, the purpose of removing the pump mirror is to align the dye laser to the pump laser by allowing the pump beam to enter the input aperture and exit the alignment aperture (Figure 3-3, item 10). The pump mirror must be moved out of the beam path. In many cases, this can be accomplished by pressing down on the horizontal mount (Figure 3-X, item X). This method avoids the need for re-alignment. The pump beam must be at

low power and the pump mirror must not be allowed to clip the pump beam.

- Method 2. The coarse horizontal adjust screw (Figure 3-2, item 10) can be removed and the entire P1 assembly can then be removed. This method causes the coarse horizontal adjustment to be lost.

  If this method is used, after re-installing the pump mirror, remove fold mirror M2. With the P1 coarse horizontal adjust screw (Figure 3-2, item 10) loosened, manually steer the pump beam into the alignment aperture (Figure 3-2, item 2). This should be done at low pump power.

- Method 3. The P1 mount adjustment retaining screw (Figure 3-2, item 11) can be loosened and the mount containing the optic can be removed. Removal in this manner requires a full re-alignment since the rotational and vertical adjustments will be lost. If this method is used, perform the full alignment after installing P1.

- Method 4. Loosen the optic retaining screw (Figure 3-2, item 26). This method may not disturb the laser alignment when done carefully, however; the optic may be difficult to access and install.

3. Installation is the reverse of removal. Ensure the stripe on the mirror is vertical as shown on Figure 7-3.

Figure 7-5. Pump Mirror Orientation

Beam Dump Removal and Installation

1. Perform the "general preparation for removal" procedures located in the preceding section titled, "Optics and Components Removal and Installation".

2. Loosen the hex nut (Figure 3-2, item 26). The beam dump can now be removed from the mounting finger.

3. Installation is the reverse of removal. To avoid damage to M2 and to avoid cavity instability, the beam dump

must be positioned to prevent the residual pump beam from striking fold mirror M2 or the M2 mount at powers exceeding 150mW.

If a water cooled beam dump is to be installed, the catch tube must first be removed. The water cooled beam dump is part of the high power kit which includes the water lines.

The location of the water lines that enter and exit the laser head are shown on Figure 3-3, item 9. Refer to Figure X-X for an interconnection diagram showing the water lines including the tee connectors provided in the high power kit.

BRF Removal and Installation

1. Perform the "general preparation for removal" procedures located in the preceding section titled, "Optics and Components Removal and Installation".

2. Remove the screw (Figure 3-3, item 4) securing the BRF assembly to its mount.

3. If further disassembly is required (i.e. to change from a one plate to a three plate BRF or vice versa), loosen the setscrew (Figure 6-1, item 4) that fastens the securing ring (item 3) to the BRF assembly frame (item 6).

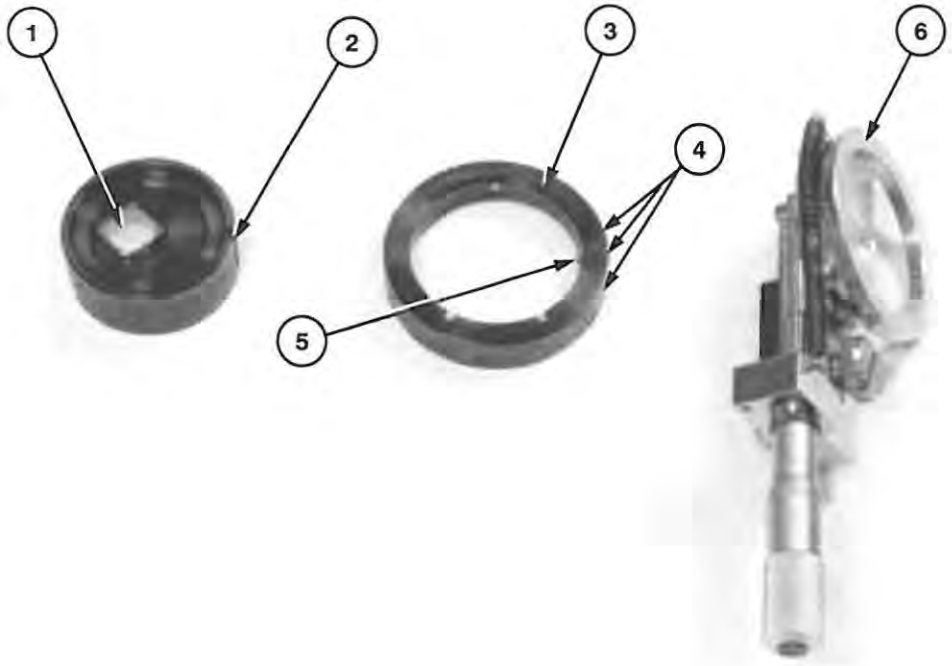
   There are three holes in the securing ring (refer to XX for the purpose of the three holes). Note the hole in which the setscrew is inserted. Remove the securing ring and the optic holder.

4. Installation is the reverse of removal. If a different BRF has been installed, it will be necessary to establish the tuning order. Refer to XX for this procedure.

   Note that a one plate BRF is normally used with a high power pump laser (10 or more Watts). A high power pump laser also requires installation of a high power kit which includes a water cooled beam dump.

Dye Input Hose Removal and Installation

1. Perform the "general preparation for removal" procedures located in the preceding section titled, "Optics and Components Removal and Installation".



1. BRF crystal
2. Optic holder
3. Retaining ring
4. Setscrew positions
5. Dowel pin
6. BRF micrometer assembly

Figure 7-6. Birefringent Filter

2. Have paper towels on hand in case of spills. Place a 3/8" open end wrench on the machined flat surface (Figure 3-2, item 20) to maintain the jet nozzle at Brewster's angle while unscrewing the nut (Figure 3-2, item 22) securing the dye input hose. After removal, position the hose in a manner to avoid dye spills.

3. If necessary, remove the hose from the JET SUPPLY connector on the dye circulator.

4. Installation is the reverse of removal.

Dye Return Hose Removal and Installation

1. Perform the "general preparation for removal" procedures located in the preceding section titled, "Optics and Components Removal and Installation".

2. Loosen the retaining screw (Figure 3-4, item 1). Have paper towels on hand in case of spills. The dye return

hose fits over a lip as shown on Figure 7-7. Slowly pull while rotating the dye return hose to remove it. After removal, position the hose in a manner to avoid dye spills.

3. If necessary, remove the hose from the JET RETURN connector on the dye circulator.

4. Install the dye input hose as follows:
   - Insert the dye input hose over catch tube lip as shown on Figure 7-7.
   - Tighten the retaining screw firmly but do not overtighten. Overtightening may cause distortion in the hose which may cause a dye leak.

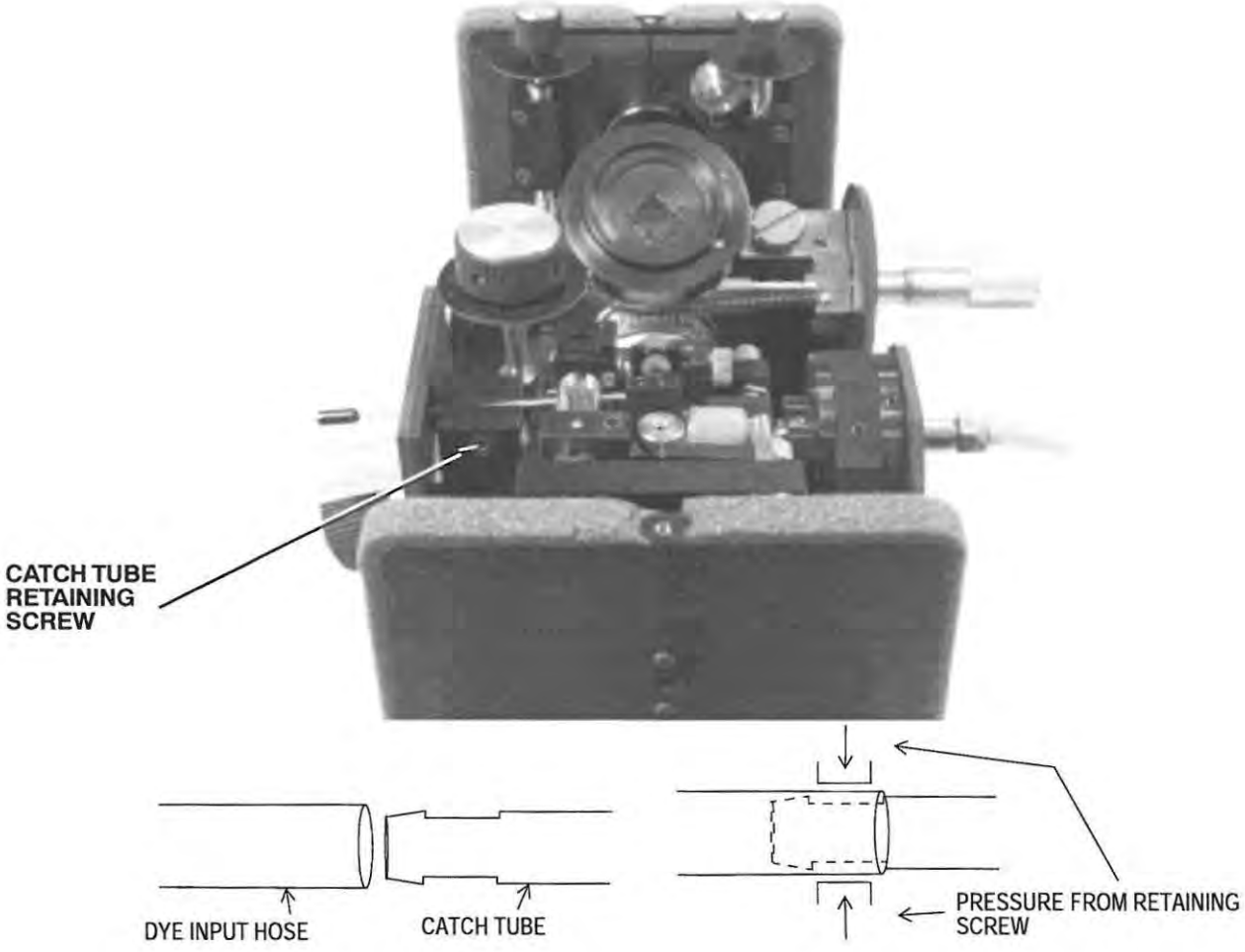


Figure 7-7. Dye Return Hose Installation

Catch Tube Removal and Installation

1. Perform the "general preparation for removal" procedures located in the preceding section titled, "Optics and Components Removal and Installation".

2. Remove the catch tube by first removing the dye input and return hoses and the dye jet translation assembly as follows:

   - Have paper towels on hand in case of spills. Remove the dye input hose as described in the section titled, Dye Input Hose Installation and Removal.
   - Remove the dye return hose by as described in the section titled, Dye Return Hose Installation and Removal.
   - Remove the dye jet translation assembly as described in the section titled, Dye Translation Assembly Installation and Removal.
   - Unscrew and remove the neutral density handle (Figure 3-1, item 10).
   - Note the position of the catch tube so that it can be reinstalled in the same position. The catch tube is oriented so that the pump beam passes though parallel to the cutout edges (Figure 3-2, item 7) without clipping.
   - Loosen the catch tube retaining screw (Figure 3-2, item 6) and remove the catch tube.

3. Installation is the reverse of removal. Ensure the catch tube is reinstalled in the same position as prior to removal.

   The catch tube must be oriented so that the pump beam passes though parallel to its edges and does not clip the pump beam.

Dye Jet Translation Assembly Removal and Installation

1. Perform the "general preparation for removal" procedures located in the preceding section titled, "Optics and Components Removal and Installation".

2. Remove the dye input hose by as described in the section titled, Dye Input Hose Installation and Removal.

3. Note there is some vertical adjustment of the dye nozzle when this screw is loosened that will be lost during this step.

   Remove the dye jet translation assembly light shield (Figure 3-3, item 7) by removing the light shield retaining screw (item 8).

4. Loosen the translation assembly retaining screw (Figure 3-2, item 21) and remove the translation assembly.

5. Installation is the reverse of removal. The dye jet nozzle will require re-centering after installation is complete.

Dye Jet Nozzle Removal and Installation

1. Perform the "general preparation for removal" procedures located in the preceding section titled, "Optics and Components Removal and Installation".

2. Place a 3/8" open end wrench on the machined flat surface (Figure 3-2, item 20) while unscrewing the nut (Figure 3-4, item 6) securing the dye jet nozzle.

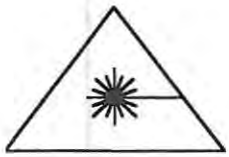
3. Installation is the reverse of removal.

Full Optical Alignment

This procedure provides full optical alignment procedures for the dye laser.

Initial Alignment to Pump Laser Beam

If the system is already aligned to a pump laser, proceed to the section titled, "Dye Laser Alignment".



Ensure all personnel in the area are wearing laser safety glasses appropriate for the wavelengths and power levels produced by the ion pump laser and the 599 dye laser.

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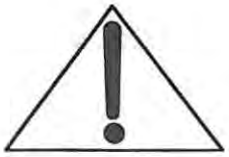
1. Turn on the pump laser in accordance with the pump laser's operator's manual. Ensure the output meets or exceeds all specifications.



The following procedure should be done with the pump laser at low power (<150 mW).

Allowing the pump beam to strike fold mirror M2 at a higher power with the dye jet stream off could result in damage to the optic.

---

2. Set the pump laser to 150 mW or less.
3. Block the pump beam with a power meter or other device (with a power absorbing non-reflecting surface) to prevent it from entering the dye laser cavity.
4. Set the FLOW switch on the dye circulator to OFF.
5. Remove the following items from the dye laser head:
   - Output coupler M3 as described in the section titled, Output Coupler M3 Removal and Installation.
   - Birefringent filter (BRF) assembly as described in the section titled, BRF Removal and Installation.
   - Pump mirror assembly as described in the section titled, Pump Mirror P1 Removal and Installation. The purpose of removing the pump mirror is to

allow the incoming pump beam to enter the alignment aperture at the other end of the laser. Pressing the horizontal adjust may sufficiently offset the pump mirror to enable the incoming pump beam to travel past the pump mirror without clipping.

- End mirror M1 as described in the section titled, End Mirror M1 Removal and Installation.
- Fold mirror M2 as described in the section titled, Fold Mirror M2 Removal and Installation.
- Catch tube as described in the section titled, Catch Tube Removal and Installation.

6. **Align the 599 to the pump laser beam.**

Unblock the pump beam. Direct the pump laser beam so that it enters the 599 through the center of the pump beam input aperture (Figure 3-1, item 5) and exits through the center of the pump beam alignment aperture (Figure 3-3, item 10).

Use the three laser head height/leveling adjustments (Figure 3-1, item 6) if necessary to adjust the height of the laser head while maintaining the base of the laser level. After adjustment, tighten the foot adjustment and lock the laser to the optical table using the optional foot clamps. Recheck the adjustment after locking down the laser.

Block the pump beam.

7. **Install the pump mirror assembly.**

If the pump mirror was not removed in step 5, this step can be omitted after verifying the following:

- The pump beam enters the pump mirror alignment aperture (Figure 3-2, item 2).
- The pump mirror coating stripe must be vertical as shown on Figure 7-5.
- The pump beam must strike the pump mirror is in the upper one-third of the mirror.

If all of these conditions are not met, perform step 7 in its entirety.

If the pump mirror was removed or if the above conditions were not met, perform the remaining procedures.

Adjust the pump mirror vertical and horizontal translation adjust controls (Figure 3-1, items 4 and 8) so that they are in the middle of their travel (refer to Figure 7-8).

As described in the section titled, Pump Mirror Removal and Installation, installation is dependent or the method used to remove it. Install the pump mirror assembly in accordance with the pump mirror removal and installation procedures. Ensure the pump mirror coating stripe is vertical as shown on Figure 7-5.

THIS IS A DRAWING OR PHOTO OF THE APPROXIMATE POSITION OF THE PUMP MIRROR CONTROLS MID POSITION (MID-TRAVEL)

Figure 7-8. Centering the Pump Mirror Controls

Unblock the pump laser beam and manually position the pump mirror assembly so that the pump beam is in the upper one-third of the pump mirror. The pump mirror has several manual coarse adjustments. Refer to Table 3-2, items 10 and 11. The pump mirror vertical and horizontal translation adjust controls are fine adjustment controls and should not be used to make coarse manual adjustments.

Manually position the reflected pump beam into the pump mirror alignment aperture (Figure 3-2, item 2). Adjust the P1 focus adjust (Figure 3-2, item 9). so that the slide is 2 mm past the main assembly (Figure 7-9).

8. Install fold mirror M2 assembly. Refer to the section titled, Fold Mirror M2 Removal and Installation.

For high power pumping (10 or more Watts), install water cooled beam stop before the catch tube is installed.

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9. Install the catch tube. Refer to the section titled, Catch Tube Removal and Installation. The catch tube should be oriented in the same position prior to removal (i.e. pump beam parallel to catch tube edges without clipping the pump beam).

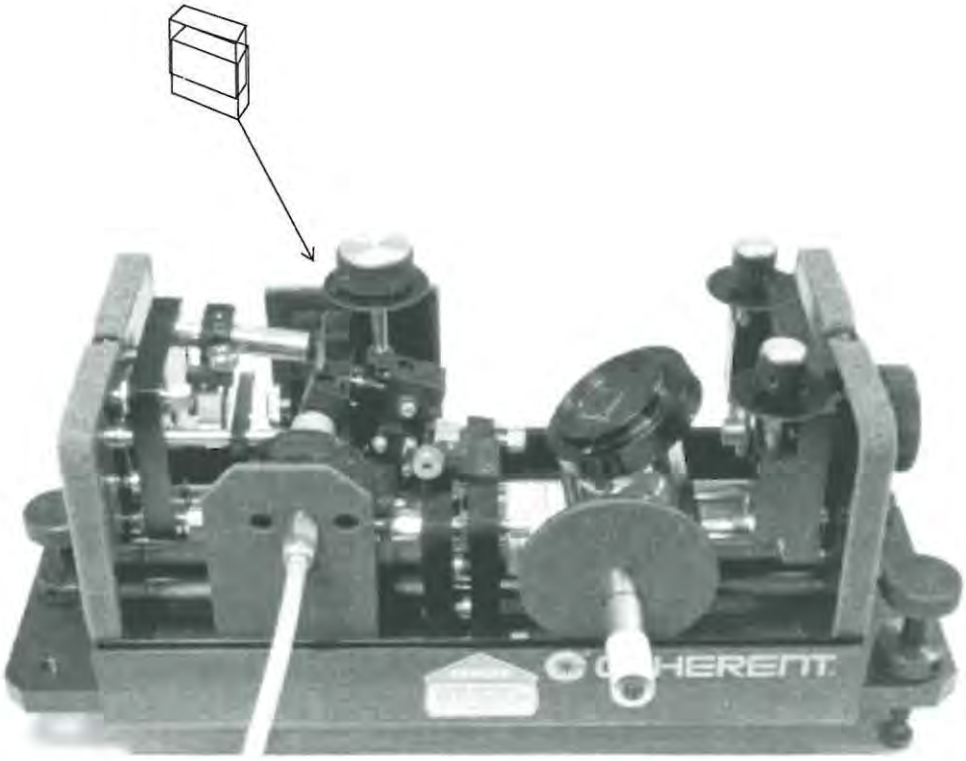


Figure 7-9. Pump Mirror Initial Focus Position

Dye Circulator

This procedure assumes that the dye circulator has been properly installed in accordance with the procedures in Chapter Five, Installation and Alignment.

Additionally, it is assumed the dye circulator is clean and has a new filter. This is particularly important if the dye has exceeded the recommend operating hours, or if a different dye will be used during alignment. If not, clean the dye circulator and install a new filter in accordance with the section titled, Changing Dyes.

Dye Laser Alignment

1. **Align jet position.**

   Ensure the boot is in place and the neutral density filter is in position over the catch tube jet stream opening (Figure 3-2, items 8 and 19).

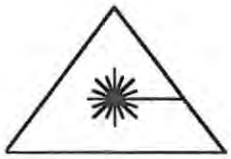
Set the FLOW switch on the dye circulator to the PUMP position. Adjust the PRESSURE regulator knob to read 40 psi on the pressure indicator.

Set the FLOW switch to the JET position to establish dye flow. View the pump beam in the dye jet. If the pump beam is centered in the dye jet and the dye jet stream strikes the dye return hose approximately 1/2" (1/4" to 3/4" is acceptable) outside the laser head, continue to Step 2.

If not, use the two (2 O'clock and 8 O'clock position) pointing screws (Figure 3-4, item 2) on the dye jet translation assembly to adjust the jet position so that the pump beam is centered and the dye jet stream strike point is correct. The opposing screws are interactive. For example, the 2 O'clock position screw should be loosened before the 8 O'clock position screw is tightened, and vice versa.

Use the dye circulator PRESSURE regulator knob to increase the pressure until bubbles or turbulence are observed in the dye return hose. Decrease the pressure until no bubbles or turbulence are visible.

2. **Set the dye absorption.**



This step involves directing the pump beam out of the laser cavity. Ensure all personnel are wearing safety glasses appropriate for the wavelengths and power levels produced.

This step can be accomplished by mounting a user supplied concave mirror on a table clamp located outside of the laser that allows the mirror to be positioned in the pump beam path. The mounted mirror should direct the pump beam onto a power meter head. This setup should emphasize safety especially with respect to beam pointing and should set up using a low pump beam power output.

Adjust the pump laser power to 5 W or to maximum power if the pump laser output power is less than 5 W.

The dye absorption is set at 80% absorption of the pump beam. This can be accomplished by using a mirror to

direct the pump beam to a power meter and measuring the power with the jet on then with the jet off. Adjust the dye solution in the pump module until the dye absorbs 80% of the pump beam power.

$$\text{ABSORPTION} = \frac{\text{OUTPUT POWER WITH DYE JET STREAM ON}}{\text{OUTPUT POWER WITH DYE JET STREAM OFF}} \times 100\%$$

Do not allow the pump beam to strike fold mirror M2.

Typically, a higher absorption will red shift the tuning curve and a lower absorption will yield lower powers with very little extension of the blue end. Too high an absorption can cause thermal lensing of the jet and instabilities.

3. Align the optics.

a. Clean fold mirror M2 and end mirror M1 in accordance with the cleaning procedures located in this chapter.

Install the mirrors in their mounts in accordance with the applicable removal and installation procedures located in this chapter.

b. Loosen the M2 mount assembly adjust (Figure 3-2, item 3) securing fold mirror M2 assembly in place. Move the M2 mirror assembly to the center of its travel. If necessary, move the pump beam dump (Figure 3-2, item 27) by loosening the pump beam dump retaining screw (Figure 3-2, item 26).

c. Using a white card (i.e. business card), locate the fluorescence spot from M2 inside the laser head.

Once the spot has been located, adjust the M2 mirror assembly (using M2 horizontal/vertical tilt angle adjusts, and the pivot adjust) so that the spot can be seen outside the cavity on a white card at least 130 cm away.

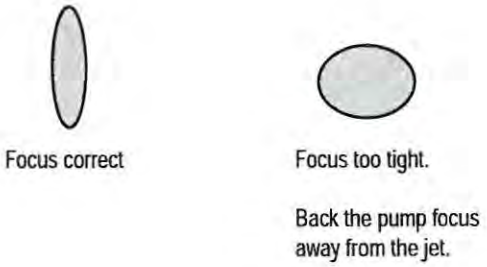
d. Move the M2 fold mirror mount back and forth to adjust the spot until it is as sharp as possible.

Tighten the fold mirror mount using the M2 mount assembly adjust. Using the M2 horizontal and vertical tilt angle adjusts (Figure 3-2, item 25), position the spot so that it is centered in the output coupler mount hole. A lens tissue over the output coupler mount hole can assist in centering the spot.

e. Loosen the pump beam stop retaining screw (Figure 3-2, item 26) and position the beam stop to block the unabsorbed pump beam.

f. Adjust the pump mirror focus (Figure 3-2, item 9) so that the fluorescence spot (from M2) is vertically elongated as shown below.

g. Adjust the pump mirror focus until the fluorescence spot begins to get round and back up 1/4 to 1/2 turn.



h. Locate the fluorescence spot from end mirror M1.

Using the M1 horizontal and vertical tilt angle adjusts (Figure 3-2, items 16 and 18) and the M1 pivot adjust (item 17), position the M1 spot next to the spot from fold mirror M2.

Adjust M1 (using items 16, 17, and 18) so that the M1 spot is the same size as the M2 spot.

Slowly move the white card between 130 cm and close to the laser. The spots should remain the same size. If not, repeat the adjustment.

Overlap the two spots using the M1 adjustments.

4. Install the output coupler.

a. Clean both sides of the output coupler. If a 12.5 mm optic is being installed, install the optic in the optic adapter, (Figure 7-4, item 4).

Insert the optic holder and install the retaining ring. Make sure the caret (>) on the edge of the optic faces in toward the dye jet stream.

b. Rock the output coupler assembly in the vertical axis by pushing on the output coupler vertical tilt angle adjust (Figure 3-1, item 3) in a front to back motion.

Locate the retro-reflection from the output coupler (the reflection can be seen inside the cavity).

Adjust the output coupler horizontal tilt angle adjust so that the retroreflection passes through the fold mirror M2 aperture.

Once the laser flashes, adjust the vertical tilt angle adjust until lasing occurs.

If the laser does not lase after moving the output coupler back and forth a few times, repeat Steps 3 and 4.

Peak the laser power using the output coupler horizontal and vertical tilt angle adjust.

5. Optimizing and tuning

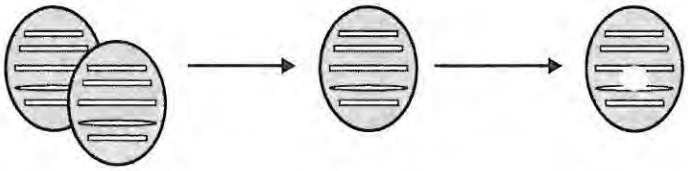
During the following procedure, the output power may decrease or the system may quit lasing. The output coupler and pump mirror vertical/horizontal controls can be used to optimize output power or re-establish lasing.

a. Optimize the dye jet stream for best transmission (Brewster's angle).

Locate the fluorescence spots from the dye jet on the ceiling. Using a 3/8" open-end wrench on the machined area (Figure 3-4, item 1) of the dye jet nozzle, rotate the dye nozzle until the intensity goes through a minimum.

Set the nozzle at the minimum. If two fluorescence spots are visible, adjust the two (2 O'clock and 8 O'clock position) pointing screws (Figure 3-4, item 2) to overlap the two spots into one spot.

PUMP JET FLUORESCENCE SPOTS



Two jet surfaces not overlapped.

Adjust jet pointing screws.

Jet surfaces overlapped but not at Brewster's angle.

Rotate jet. nozzle

Jet surfaces overlapped and at the correct angle.

b. Install the BRF assembly. If lasing occurs, continue. If the system does not lase, check to see that the fluorescence spots go through the BRF aperture cleanly and repeat the rocking motion in Step 4.

c. Peak the output coupler for power and adjust the BRF for maximum power.

d. Make small adjustments to M2 and/or the pump mirror focus to obtain the desired mode and power. Make one adjustment at a time.

e. If the pump laser power is increased, the pump mirror must be slightly moved away from the dye jet stream and the M2 position must be re-optimized.

Changing/ Replenishing dyes

To avoid reduced performance, the dye must be replenished after exceeding the lifetime hours given in Appendix A.

When changing to a different dye or when replenishing an existing dye, the dye circulator must be thoughly cleaned and a new filter installed to avoid contamination of the new or replenished dye. In general, more care should be exercised when changing dyes than when replacing a dye with a fresh batch, since remnants of old dye may absorb in the new dye's lasing bandwidth or otherwise hinder the new dye performance. This is especially true when the new dye lases bluer than the old dye.

Refer to the section titled, Mixing Dyes, and to Appendix A, Tuning Curves, for information on dye receipes, solvents, premixes, associated wavelengths and optic sets, dye lifetime, and other related data.

Change to a different dye or replenish an expended dye as follows:

Because of the toxicity of some of the dyes involved, it is recommended that all dyes be considered dangerous and that the following precautions are observed:
• Wear plastic gloves when handling dyes and solvents.
• Open and mix dyes under a fume hood. Avoid breathing powdered dye.
• Dispose of used dyes in a safe manner and in accordance with local or federal regulations.
• Ensure an ample supply of disposable towels are available for minor spills and cleanup.

- Clean the dye circulator in accordance with the section titled, Cleaning the Dye Circulator.
- Clean all components in the dye circulation system in accordance with the section titled, Cleaning Dye Circulation System Components.
- Mix the new dye in accordance with the section titled, Mixing Dye.
- Check the absoption in accordance with the full alignment procedures under the subsection titled, Dye Laser Alignment (step 2. "Set the dye absorption").

- Optimize the laser output power and check the mode.

Cleaning the Dye Circulator

To avoid degraded performance, the dye circulator must be cleaned and a new filter installed when changing to a different dye or when replenishing an expended dye. Use of proper solvents greatly facilitates cleaning of the dye circulation system.

Because of the toxicity of some of the dyes involved, it is recommended that all dyes be considered dangerous and that the following precautions are observed:

- Wear plastic gloves when handling dyes and solvents.
- Open and mix dyes under a fume hood. Avoid breathing powdered dye.
- Dispose of used dyes in a safe manner and in accordance with local or federal regulations.
- Ensure an ample supply of disposable towels are available for minor spills and cleanup.

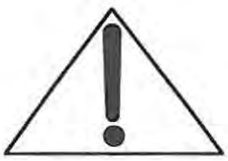
1. Set the dye circulator FLOW switch to the OFF position.
2. Remove the dye input and return hoses from the laser head in accordance with the applicable sections in this chapter.
3. Remove the dye circulator cover using the cover thumbscrews (Figure 3-6, item 10). Remove the dye reservoir cover (Figure 5-2, item 3).
4. Place the dye input hose in a dye waste container. Set the dye circulator FLOW switch to the JET position until the reservoir is empty of dye. Tilting the rear of the dye circulator upwards will assist in draining any excess dye.
5. Set the dye circulator FLOW switch to the OFF position.
6. Place paper towels around the blue filter housing.

Figure 7-10. Dye Circulator Filter Assembly

7. Remove the filter housing by turning the housing counterclockwise (an oil filter wrench may be required).

8. Remove and discard the dye filter. Do not discard the positioning adapter or the grommets (refer to Figure 7-10). Re-install the empty filter housing.

9. Fill the reservoir with methanol or ethylene glycol.



Be extremely careful when cleaning the dye circulator not to leave rags, paper towels, etc., close to the circulator. These quickly become soaked in ethylene glycol which is highly flammable.

10. Set the FLOW switch to the PUMP position and turn the PRESSURE regulator knob clockwise approximately five turns.

11. Let the dye circulator run for one minute.

12. Drain the reservoir as in Step 2.

To avoid reduced performance, all components that come in contact with the dye during normal operation must be thoroughly cleaned and a new filter must be installed.

13. Repeat steps 9 through 12 until the fluid is clear.

    If all other components in the dye circulation system are clean, proceed to step 14.

    If not clean the remaining components in accordance with the section titled, Cleaning Dye Circulation System Components, prior to proceeding to step 14.

14. Install a new dye filter.

15. Mix and add the new dye to the dye circulator in accordance with the section titled, Mixing Dye.

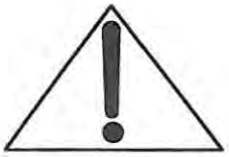
Mixing Dye

In the following procedures, "A", "B", and"C" refer to the columns in Table 7-X.

1. Pour "C" ml of solvent into a clean container.

All dyes should be considered dangerous. Use plastic gloves when handling powered dye and dye solutions and mix dye under a fume hood.

2. Dissolve "A" grams of dye in "B" ml of premix solvent. Add 75% of this premix to the solvent.



The following step assumes that the dye circulator has been cleaned in accordance with the dye circulator cleaning procedures and that a new filter cartridge has been installed. This applies to replenishing an existing dye and to changing to a different dye. Failing to do so will result in degraded laser performance.

3. Pour the mixture from step 2 into the dye circulator reservoir.

4. After lasing is established, add small amounts (eyedropper) of the premix to the dye circulator reservoir until there is no further increase in power output.

Cleaning The Jet Nozzle

1 Remove the dye jet holder by removing the two 5/64 inch screws securing it to the dye jet tip plate as shown in Figure X-X.

2 Put the dye jet holder into an ultrasonic bath of the appropriate chemical used to mix the old dye. Allow to sit for approximately 20 minutes.

3 Put the dye jet holder back in place and connect the dye jet feed hose removed earlier.

Filling the System With Dye

1. Install a new cartridge in the filter can.

2. Fill the reservoir with ethylene glycol.

3. Run the dye circulator for 1 or 2 minutes with the FLOW switch in the PUMP position.

4. Briefly switch the FLOW switch to JET to eliminate any air or old dye solution remaining in the feed hose. Turn off the FLOW switch.

5. Reconnect the jet feed hose to the laser and turn the FLOW switch to PUMP until the pressure builds above 30 psi and then switch to JET.

6. Let the ethylene glycol circulate through the system for 10 minutes. Remove the jet feed hose and pump the ethylene glycol into a suitable container.

7. Refill the system with ethylene glycol and repeat step 6.

8. Fill the reservoir with the new dye solution. There should be 2-3 inches of fluid in the reservoir with the FLOW switch set to PUMP.

Removing And Cleaning The Jet Nozzle

With normally used solvents, such as ethylene glycol, it is acceptable to turn the dye circulator off overnight, or for short intervals (such as a weekend) with no special precaution with regard to the jet nozzle. For longer periods of non-use, it is necessary to flush out and clean the jet nozzle. All traces of liquid dye should be removed to prevent drying and subsequent clogging.

Remove the jet feed hose, taking care not to mis-align the jet assembly. Force a few milliliters of the solvent used to mix the dye through the nozzle until the flow is free of dye. Refer to the dye fact sheets in Appendix A for the correct solvent.

If these precautions have been taken it will not normally be necessary to remove and clean the jet nozzle during a routine dye change.

In the event of a partial clog, recognizable by an uneven or distorted jet stream, attempt to circulate solvent through the jet assembly to dissolve crystallized dye. Raising the temperature of the solvent by turning off the flow to the heat exchanger can sometimes aid in this process.

In the event of persistent or total clogging, the nozzle assembly will have to be removed and cleaned by soaking or insertion in an ultrasonic bath. Take care to preserve the jet nozzle shape. A damaged nozzle will result in poor system performance. If cleaning will not restore an optically flat and symmetrical jet, the jet nozzle must be replaced.

1. Turn off the dye circulator.

2. Note the angular position of the nozzle so that it can be re-installed at approximately the same angle. Remove

the nozzle from the laser head by unscrewing the knurled nut.

3. Blow compressed air through the nozzle in a reverse direction of normal jet flow. Be careful not to bend the nozzle, or it will not function correctly.

4. When installing the jet nozzle, be sure to bottom the nozzle fully into the jet holder before tightening the knurled nut that retains the nozzle. This will help assure smooth dye flow in the assembly.

5. The jet nozzle must be installed at Brewster's angle. Brewster's angle can be set with the system lasing while adjusting the jet nozzle for a minimum vertical reflection.

Table 7-2. Dye Quantity for Mixing

DYE	PREMIX		SOLVENT
	DYE (Grams) A	PREMIX SOLVENT (Milliliters) B	(Milliliters) C
Exalite 392E	2.0	300	700
Stilbene 1 LC 4100	1.0	200	700
Stilbene 3 LC 4200	1.0	200	700
Coumarin 102 LC 4800	1.0	200	700
Coumarin 30(1) LC 5150	0.75	300	700
Coumarin 6(2) LC 5370	2.0	200	600
Rhodamine 110 LC 5700	0.75	50	950
Rhodamine 6G(2) LC 5900	1.0	50	950
DCM Special(2) LC 6501	2.0	400	600
Kiton red(2) LC 6200	2.5	150	750
Pyridine 2 LC 7300	1.5	200	800
LD700 LC 7000	1.5	200	800
Styryl 9M LC 8400	2.0	300	700

1. An additive is used with this dye.
2. The dye mixture is applicable for both high power and low power pumping. Refer to Table B-1 for the correct optic sets.

OPERATOR'S MANUAL

APPENDIX A
TUNING CURVES

COHERENT

Introduction

The dye laser fact sheets in this appendix are intended as a reference guide on laser performance and operation. Information, other than the specifications, although accurate are not specifications, but have been achieved by Coherent factory personnel using Coherent ion laser pump sources.

If another manufacturer's laser is used to pump the dye laser, some differences in performance may be encountered and some specifications may not apply. The main problems that can be encountered are poor mode quality and high noise. If the mode quality of the pump laser is inferior in any way, power conversion will suffer and any excessive noise from the pump laser will be coupled into the output of the dye laser.

Power In vs Power Out Curves

Conversion is dependant on factors such as alignment, absorption, pump mode and the power at which the system was optimized. Therefore, the values shown are approximate. Lower thresholds can be achieved by optimizing at lower input powerw and other methods. The curves shown corresponds to a laser that was optimized for the specified pump power.

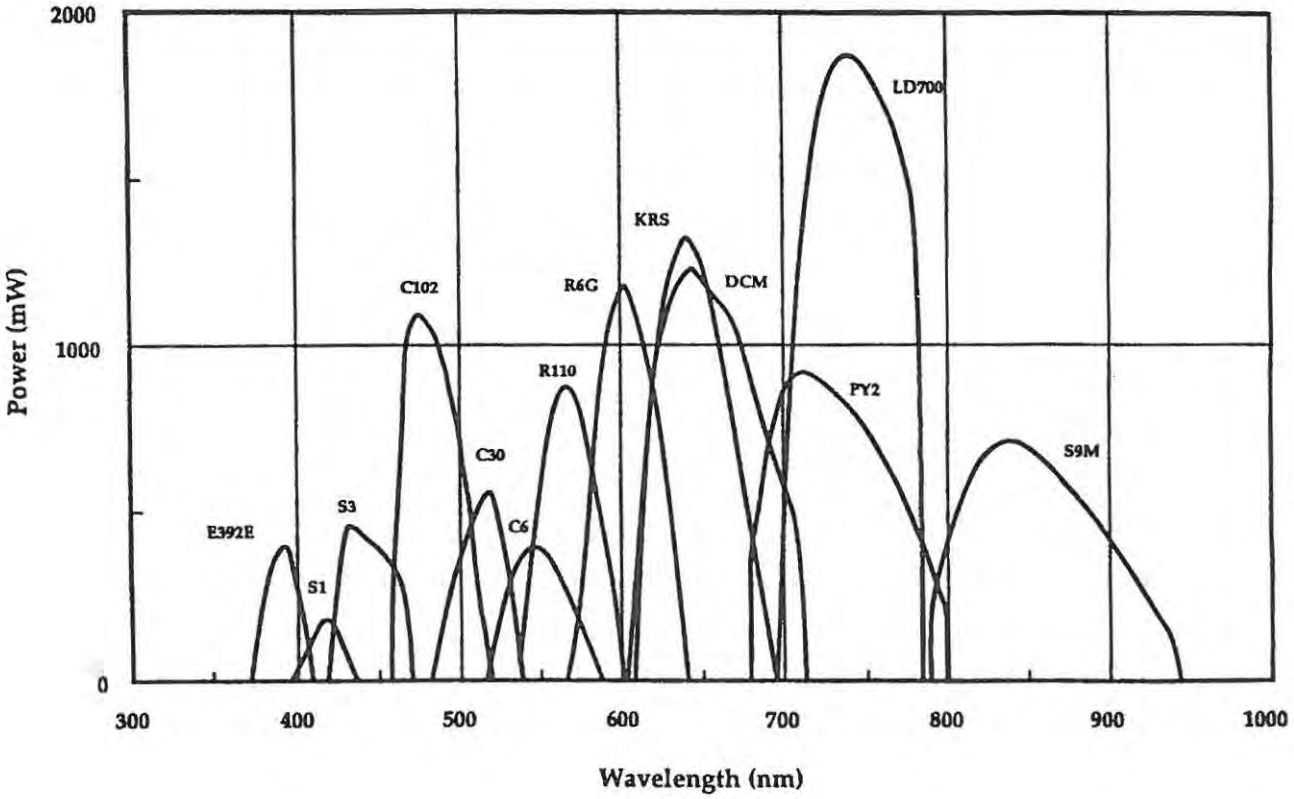
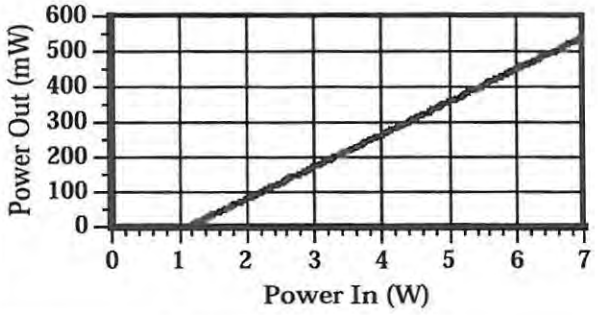


Figure A-1. Composite Tuning Curve

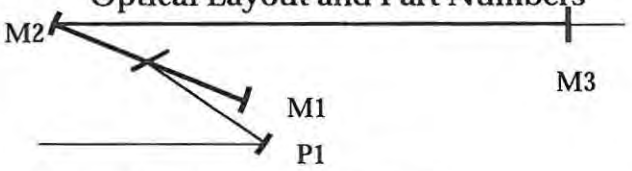
COHERENT 599 Dye Laser Fact Sheet

Dye: Exalite 392E

Power In vs. Power Out Curve



Optical Layout and Part Numbers

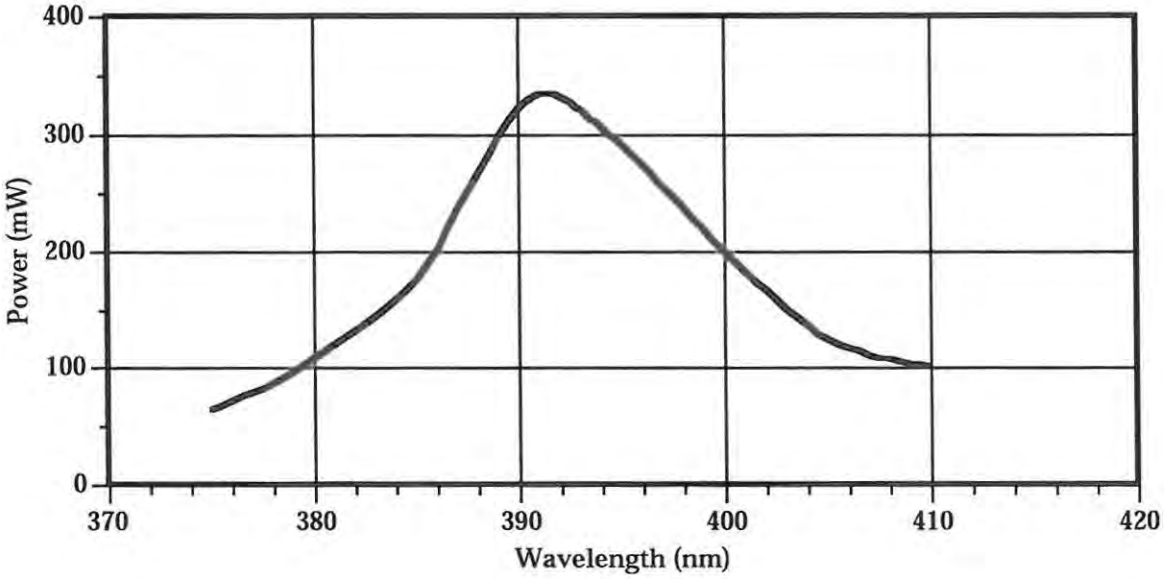


Mirror	Part Number	Rad.	Desc.	Dia.
P1	0406-721-01	75mm	Pump Mirror	4.0mm
M1	0158-787-01	50mm	End H. R.	12.5mm
M2	0158-787-01	50mm	Fold H. R.	12.5mm
M3*	0160-994-00	∞	Output Coupler	12.5mm

*Requires Optic Adapter P/N 0156-762-00

Dye Tuning Curve — Exalite 392 E — Non-Specified * See Note

Pump Power = 5.0 W @ 333.6-363.8 nm



* The numbers in this graph are not specifications, but have been achieved by Coherent, Inc. personnel.

Specifications

Pump Power: 5.0 Watts of Std. Multiline UV

Output Power: 200 mW

Linewidth

3-Plate Birefringent Filter 40 GHz

Dye Information

Dye Recipe

Amount of Dye: 3.0 grams
Premix Solvent: 300 ml Ethylene Glycol
Solvent: 700 ml Ethylene Glycol
Absorption: 80-85%
Dye Lifetime: 100 W-hours

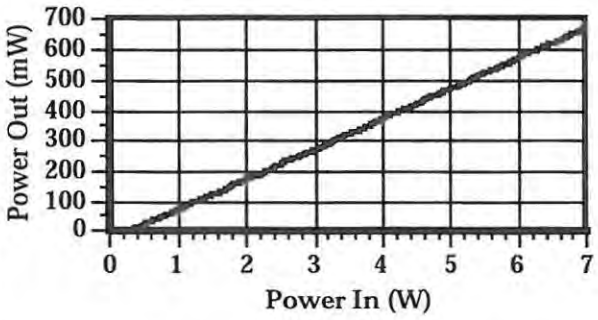
Comments

The dye should be mixed in an ultrasonic mixer until the dye completely dissolves. The dye turns brown at approximately 40 W-hours.

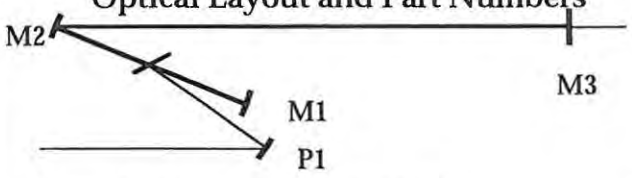
COHERENT 599 Dye Laser Fact Sheet

Dye: Stilbene 1/LC 4100

Power In vs. Power Out Curve



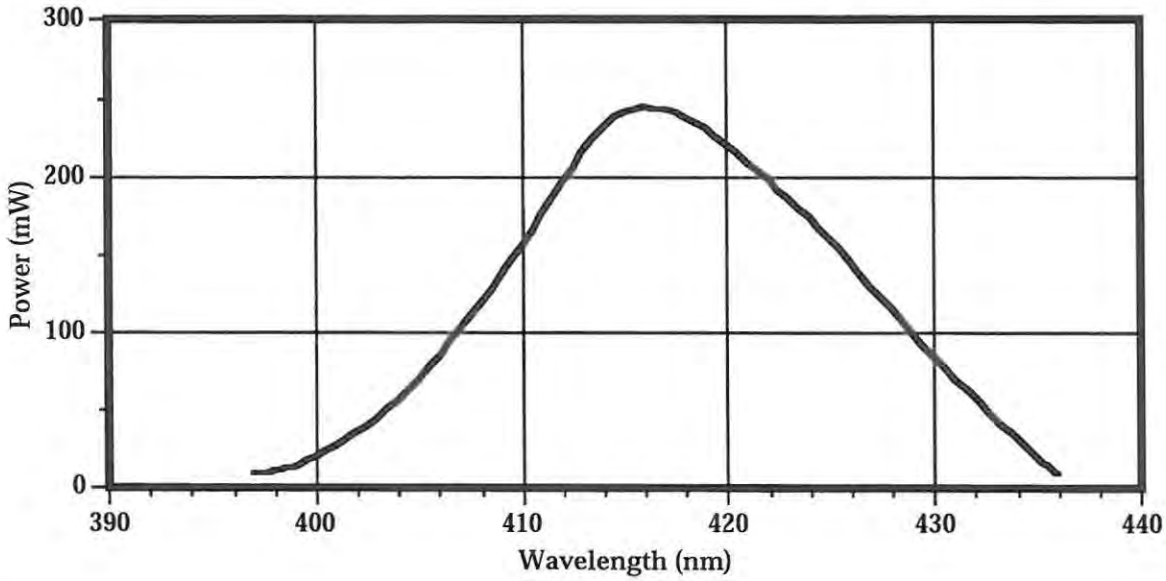
Optical Layout and Part Numbers



Mirror	Part Number	Rad.	Desc.	Dia.
P1	0406-721-01	75mm	Pump Mirror	4.0mm
M1	0158-787-02	50mm	End H. R.	12.5mm
M2	0158-788-02	75mm	Fold H. R.	12.5mm
M3	0155-272-00	∞	Output Coupler	25.4mm

Dye Tuning Curve — Stilbene 1 — Non-Specified * See Note

Pump Power = 2.5W @ 333.6-363.8 nm



* The numbers in this graph are not specifications, but have been achieved by Coherent, Inc. personnel.

Specifications

Pump Power: 2.5 W of Std. Multiline UV

Output Power: 130 mW

Linewidth

3-Plate Birefringent Filter 40 GHz

Dye Information

Dye Recipe

Amount of Dye: 2.0 Gram
Premix Solvent: 200ml Ethylene Glycol
Solvent: 700ml Ethylene Glycol
Absorption: 80-85%
Dye Lifetime: 100 W-hours

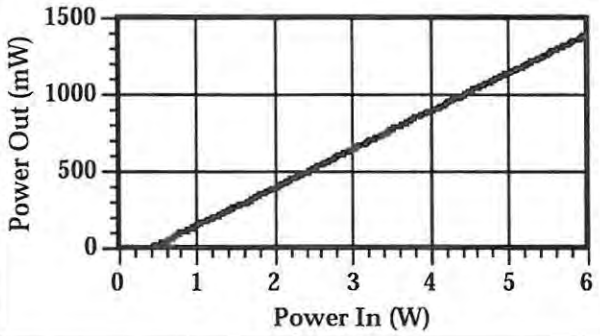
Comments

Dye should be mixed with ethylene glycol in an ultrasonic bath at 100°C until completely dissolved.

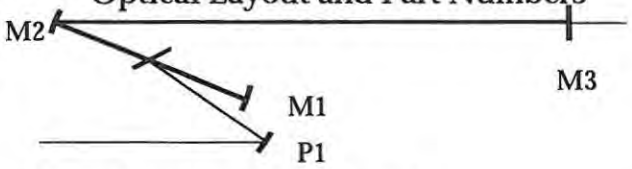
COHERENT 599 Dye Laser Fact Sheet

Dye: Stilbene 3/LC 4200

Power In vs. Power Out Curve



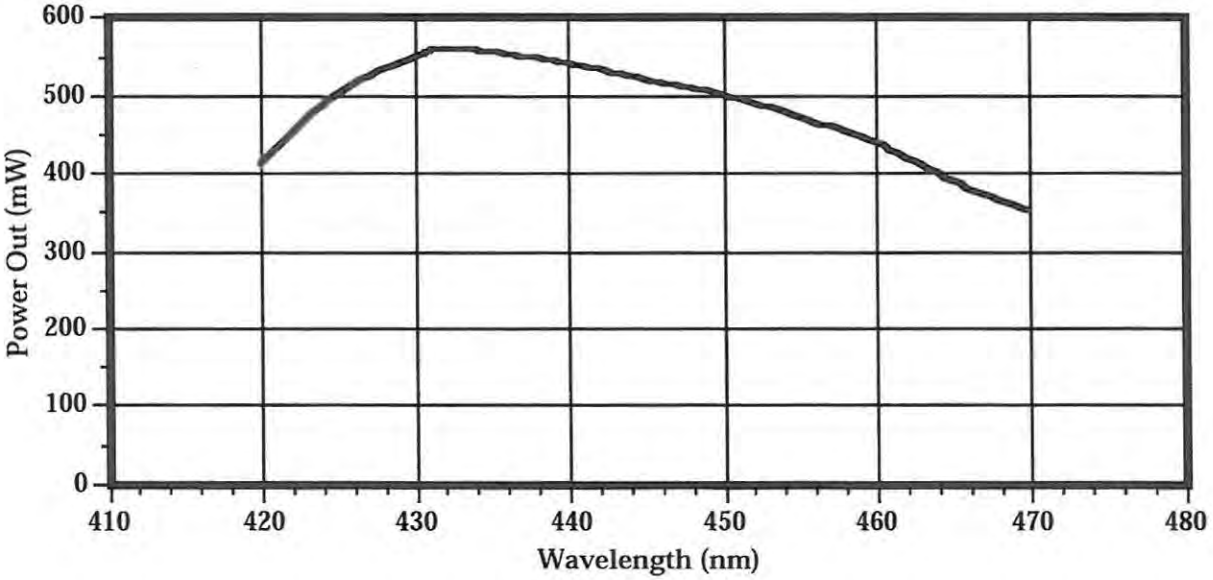
Optical Layout and Part Numbers



Mirror	Part Number	Rad.	Desc.	Dia.
P1	0406-721-01	75mm	Pump Mirror	4.0mm
M1	0158-787-03	50mm	End H. R.	12.5mm
M2	0158-788-03	75mm	Fold H. R.	12.5mm
M3	0500-836-06	∞	Output Coupler	25.4mm

Dye Tuning Curve — Stilbene 3 — Non-Specified * See Note

Pump Power = 2.5 W @ 333.6-363.8 nm



* The numbers in this graph are not specifications, but have been achieved by Coherent, Inc. personnel.

Specifications

Pump Power: 2.5 W of Std. Multiline UV

Output Power 360 mW

Linewidth

3-Plate Birefringent Filter 40 GHz

Dye Information

Dye Recipe

Amount of Dye: 0.75 Gram
Premix Solvent: 200 ml Ethylene Glycol
Solvent: 800 ml Ethylene Glycol
Absorption: 80-85%
Dye Lifetime: 100 W-hours

Comments

Dye should be mixed with ethylene glycol in an ultrasonic bath at 55°C until completely dissolved.

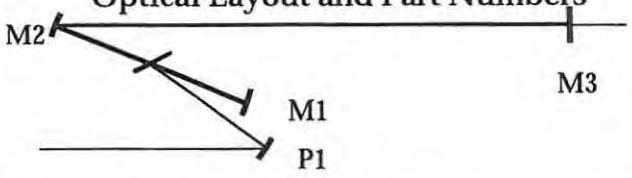
COHERENT 599 Dye Laser Fact Sheet

Dye: Coumarin 102/LC4800

Power In vs. Power Out Curve

Data Not Available

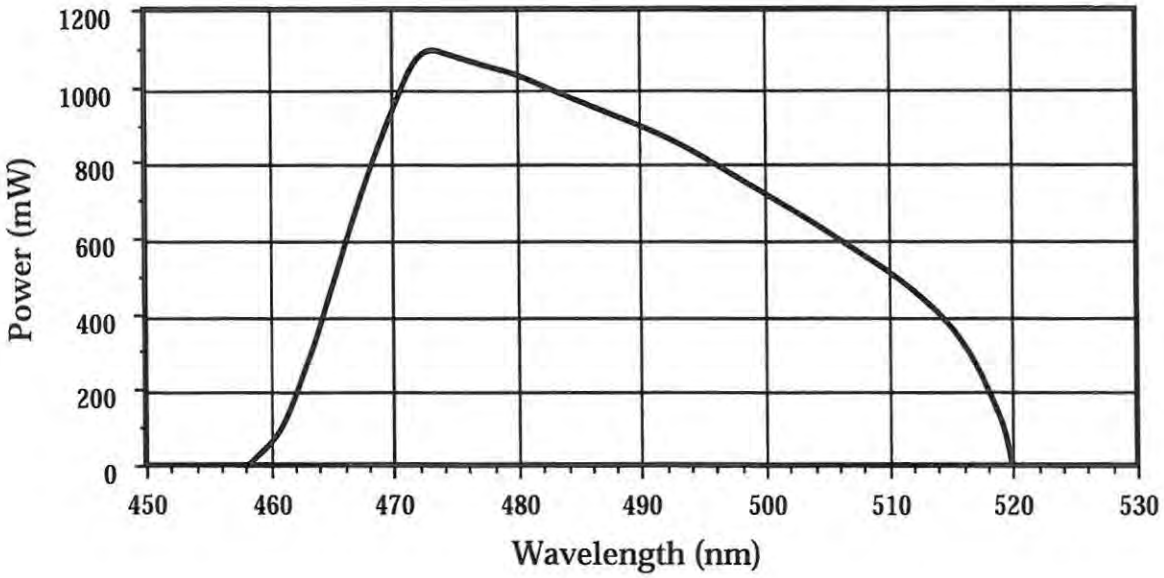
Optical Layout and Part Numbers



Mirror	Part Number	Rad.	Desc.	Dia.
P1	0406-721-03	75mm	Pump Mirror	4.0mm
M1	0158-787-04	50mm	End H. R.	12.5mm
M2	0158-788-04	75mm	Fold H. R.	12.5mm
M3	0500-836-07	∞	Output Coupler	25.4mm

Dye Tuning Curve — Coumarin 102 — Non-Specified * See Note

Pump Power = 4.8 W @ 406.7-415.1 nm



* The numbers in this graph are not specifications, but have been achieved by Coherent, Inc. personnel.

Specifications

Pump Power: 2.5W of Multiline Violet

Output Power 480 mW

Linewidth

3-Plate Birefringent Filter 40 GHz

Dye Information

Dye Recipe

Amount of Dye: 2.0 Gram
Premix Solvent: 300 ml Benzyl Alcohol
Solvent: 700 ml Ethylene Glycol
Absorption: 80-85%
Dye Lifetime: 100 W-hours

Comments

Dye should be mixed with benzyl alcohol in an ultrasonic bath until completely dissolved.

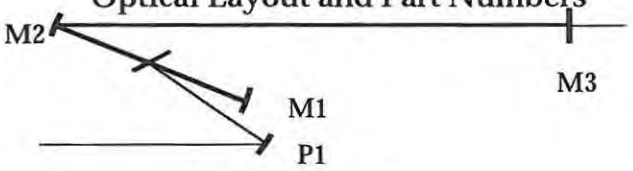
COHERENT 599 Dye Laser Fact Sheet

Dye: Coumarin 30/LC 5150

Power In vs. Power Out Curve

Data Not Available

Optical Layout and Part Numbers

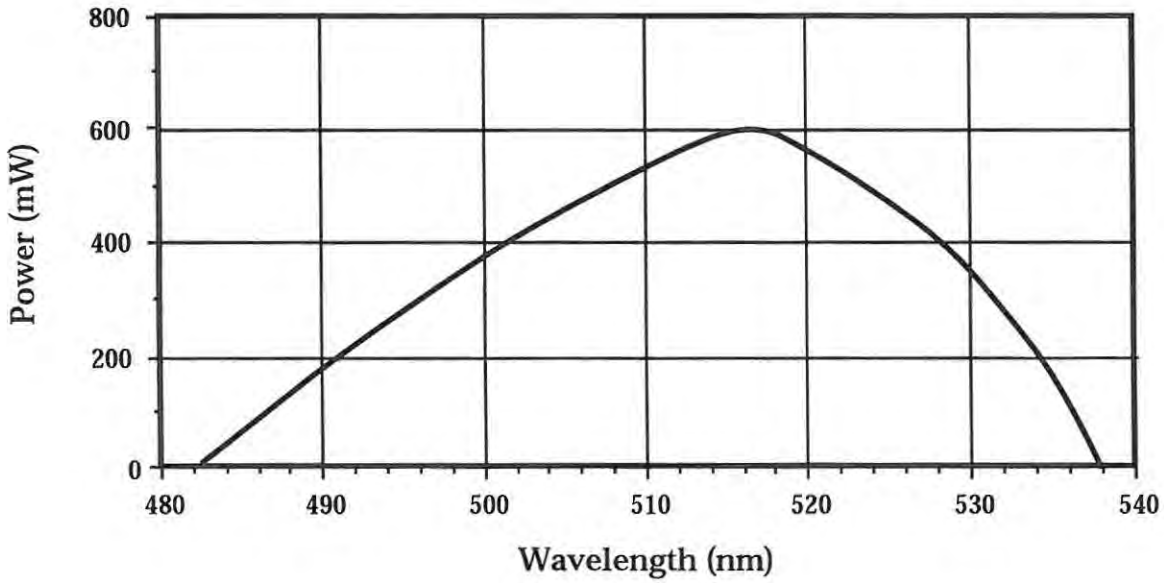


Mirror	Part Number	Rad.	Desc.	Dia.
P1	0406-721-03	75mm	Pump Mirror	4.0mm
M1	0158-787-05	50mm	End H. R.	12.5mm
M2	0158-788-05	75mm	Fold H. R.	12.5mm
M3*	0157-636-00	∞	Output Coupler	12.5mm

* Requires Optic Adapter P/N 0156-762-00

Dye Tuning Curve — Coumarin 30 — Non-Specified * See Note

Pump Power =4.6 W @ 406.7-415.1 nm



* The numbers in this graph are not specifications, but have been achieved by Coherent, Inc. personnel.

Specifications

Pump Power: 2.5W of Multiline Violet

Output Power 250 mW

Linewidth

3-Plate Birefringent Filter 40 GHz

Dye Information

Dye Recipe

Amount of Dye: 1.0 Grams
Premix Solvent: 100ml Benzyl Alcohol
Solvent: 600ml Ethylene Glycol, 200 ml Glycerol
Absorption: 80-85%
Dye Lifetime: 100 W-hours
Additive: 9-Methylanthracene (9MA) in Benzyl Alcohol

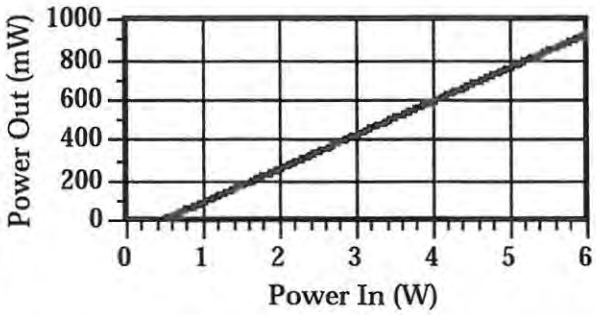
Comments

Coumarin 30 requires 9MA (a triplet state quecher) for efficient operationand extends the usefull lifetime. Add 9MA to the dye mixture until the absorption reaches 80%. Dye will come out of solution if cooled below 15°C.

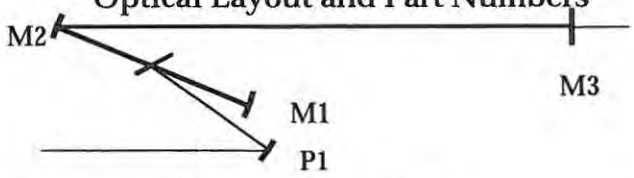
COHERENT 599 Dye Laser Fact Sheet

Dye: Coumarin 6/LC 5370

Power In vs. Power Out Curve



Optical Layout and Part Numbers

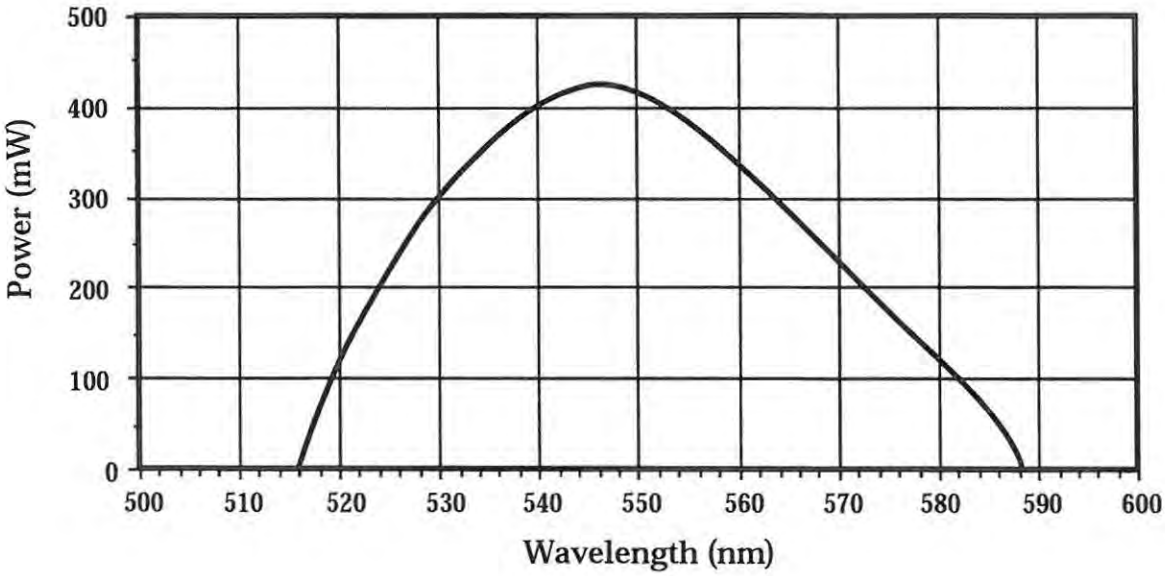


Mirror	Part Number	Rad.	Desc.	Dia.
P1	0406-721-01	75mm	Pump Mirror	4.0mm
M1	0158-787-06	50mm	End H. R.	12.5mm
M2	0158-788-06	75mm	Fold H. R.	12.5mm
M3*	0157-636-00	∞	Output Coupler	12.5mm

* Requires Optic Adapter P/N 0156-762-00

Dye Tuning Curve — Coumarin 6 — Non-Specified * See Note

Pump Power = 3.0W @ 488.0 nm



* The numbers in this graph are not specifications, but have been achieved by Coherent, Inc. personnel.

Specifications

Pump Power:	3.0 Watts of Single Line 488.0 nm
Output Power	240 mW
Linewidth	
3-Plate Birefringent Filter	40 GHz

Dye Information

Dye Recipe

Amount of Dye: 2.0 Grams
Premix Solvent: 100ml Benzyl Alcohol
Solvent: 600ml Ethylene Glycol, 200 ml Glycerol
Absorption: 80-85%
Dye Lifetime: 100 W-hours
Additive: 9-Methylanthracene (9MA) in Benzyl Alcohol

Comments

Coumarin 6 requires 9MA (a triplet state quecher) for efficient operation. Add 9MA to the dye mixture until the absorption reaches 80%. Dye will come out of solution if cooled below 15°C.

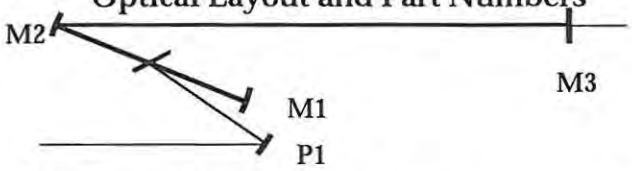
COHERENT 599 Dye Laser Fact Sheet

Dye: Rhodamine 110/LC 5700

Power In vs. Power Out Curve

Data Not Available

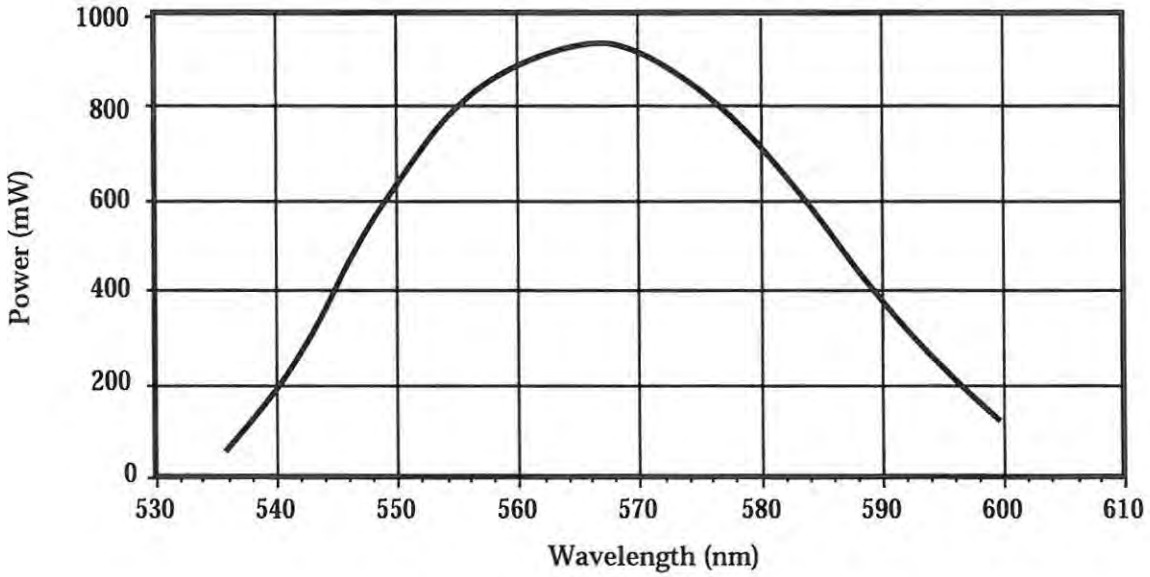
Optical Layout and Part Numbers



Mirror	Part Number	Rad.	Desc.	Dia.
P1	0406-721-01	75mm	Pump Mirror	4.0mm
M1	0158-787-06	50mm	End H. R.	12.5mm
M2	0158-788-06	75mm	Fold H. R.	12.5mm
M3	0500-836-03	∞	Output Coupler	25.4mm

Dye Tuning Curve — Rhodamine 110 — Non-Specified * See Note

Pump Power = 5.0W @ 457.9-514.5 nm



* The numbers in this graph are not specifications, but have been achieved by Coherent, Inc. personnel.

Specifications

Pump Power: 5.0 Watts of Multiline Blue-Green

Output Power: 540 mW

Linewidth

3-Plate Birefringent Filter 40 GHz

Dye Information

Dye Recipe

Amount of Dye: 0.75 Grams
Premix Solvent: 50 ml Methanol
Solvent: 950 ml Ethylene Glycol
Absorption: 80-85%
Dye Lifetime: 250 W-hours

Comments

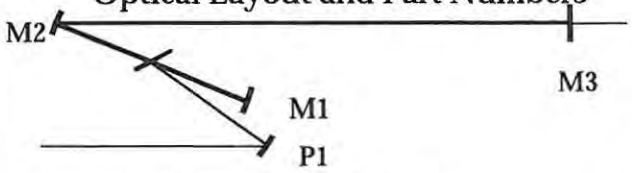
COHERENT 599 Dye Laser Fact Sheet

Dye: Rhodamine 6G/LC5900

Power In vs. Power Out Curve

Data Not Available

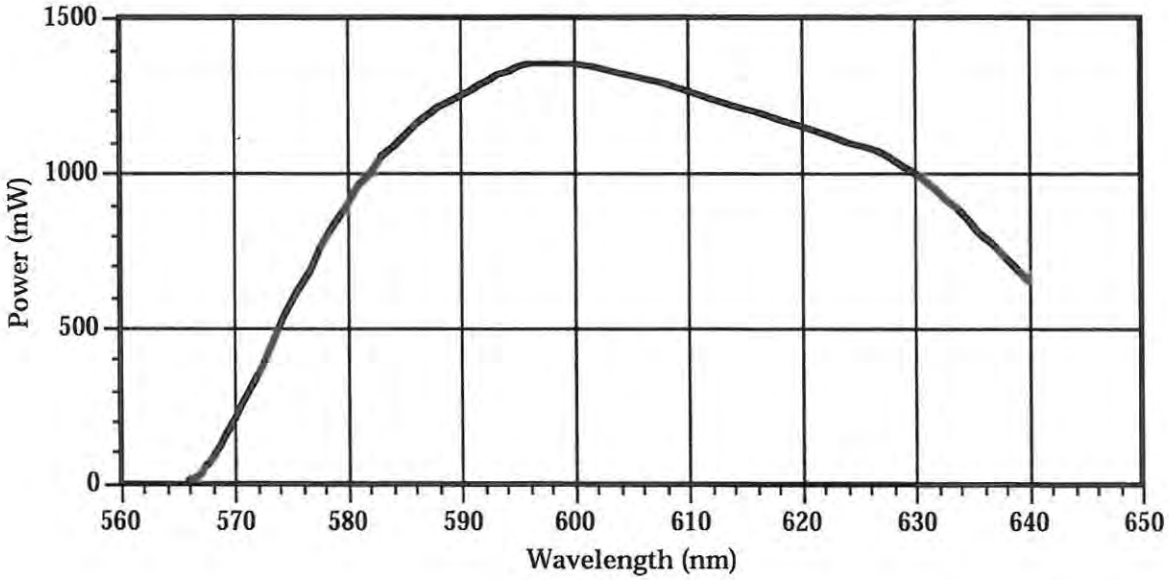
Optical Layout and Part Numbers



Mirror	Part Number	Rad.	Desc.	Dia.
P1	0406-721-01	75mm	Pump Mirror	4.0mm
M1	0158-787-07	50mm	End H. R.	12.5mm
M2	0158-788-07	75mm	Fold H. R.	12.5mm
M3	0500-836-03	∞	Output Coupler	25.4mm

Dye Tuning Curve — Rhodamine 6G — Non-Specified * See Note

Pump Power = 5.0W @ 457.9-514.5 nm



* The numbers in this graph are not specifications, but have been achieved by Coherent, Inc. personnel.

Specifications

Pump Power: 5.0 Watts of Multiline Blue-Green

Output Power: 880 mW

Linewidth

3-Plate Birefringent Filter 40 GHz

Dye Information

Dye Recipe

Amount of Dye: 1.0 Gram
Premix Solvent: 50 ml Methanol
Solvent: 950 ml Ethylene Glycol
Absorption: 80-85 %
Dye Lifetime: 1000 W-hours

Comments

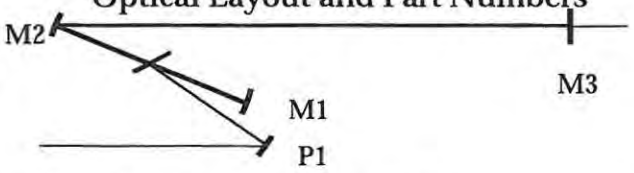
COHERENT 599 Dye Laser Fact Sheet

Dye: DCM Special/LC 6501

Power In vs. Power Out Curve

Data Not Available

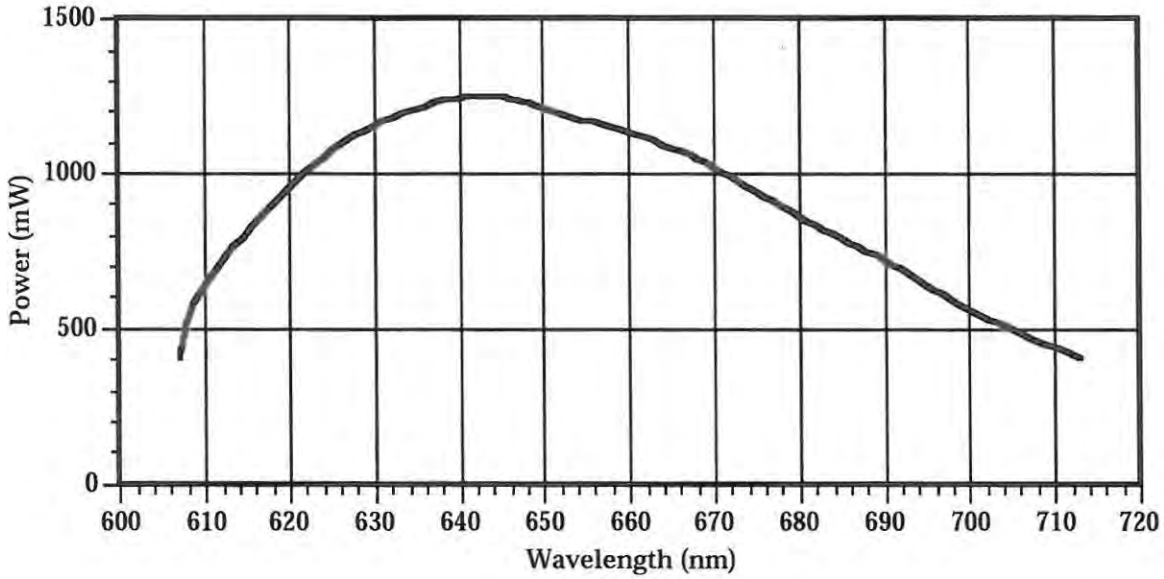
Optical Layout and Part Numbers



Mirror	Part Number	Rad.	Desc.	Dia.
P1	0406-721-01	75mm	Pump Mirror	4.0mm
M1	0158-787-08	50mm	End H. R.	12.5mm
M2	0158-788-08	75mm	Fold H. R.	12.5mm
M3	0500-836-01	∞	Output Coupler	25.4mm

Dye Tuning Curve — DCM Special — Non-Specified * See Note

Pump Power = 5.0W @ 457.9-514.5 nm



* The numbers in this graph are not specifications, but have been achieved by Coherent, Inc. personnel.

Specifications

Pump Power: 5.0W of Multiline Blue-Green

Output Power: 540 mW

Linewidth

3-Plate Birefringent Filter 40 GHz

Dye Information

Dye Recipe

Amount of Dye: 2.0 Grams
Premix Solvent: 400 ml Benzyl Alcohol
Solvent: 600 ml Ethylene Glycol
Absorption: 80-85%
Dye Lifetime: 400 W-hours

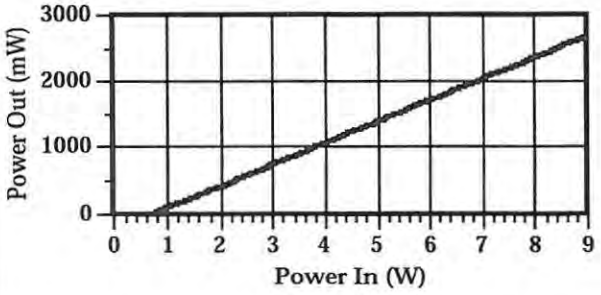
Comments

Dye should be mixed in an ultrasonic mixer until completely dissolved. The ethylene glycol should be free of water; this will prolong the dye lifetime. DCM Special (LC6501) contains a small amount of Kiton Red, which allows it to go into solution more easily, but does cause a blue shift in the tuning curve.

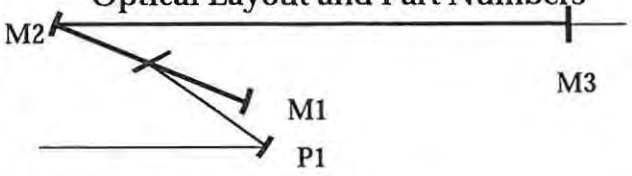
COHERENT 599 Dye Laser Fact Sheet

Dye: KitonRed/LC 6200

Power In vs. Power Out Curve



Optical Layout and Part Numbers

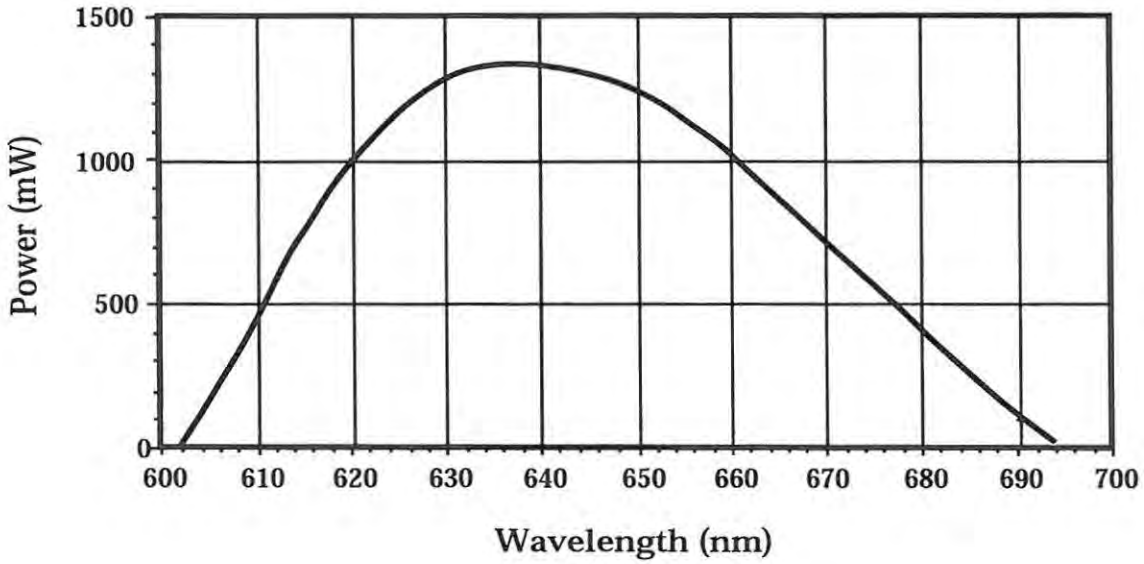


Mirror	Part Number	Rad.	Desc.	Dia.
P1	0406-721-01	75mm	Pump Mirror	4.0mm
M1	0158-787-08	50mm	End H. R.	12.5mm
M2	0158-787-08	50mm	Fold H. R.	12.5mm
M3*	0406-670-00	∞	Output Coupler	12.5mm

*Requires Optic Adapter P/N 0156-762-00

Dye Tuning Curve — Kiton Red — Non-Specified * See Note

Pump Power = 5.0 W @ 457.9-514.5 nm



* The numbers in this graph are not specifications, but have been achieved by Coherent, Inc. personnel.

Specifications

Pump Power: 5.0 Watts of Multiline Blue-Green

Output Power: 860 mW

Linewidth

3-Plate Birefringent Filter 40 GHz

Dye Information

Dye Recipe

Amount of Dye: 2.5 Grams
Premix Solvent: 150 ml Methanol
Solvent: 750 ml Ethylene Glycol
Absorption: 80-85%
Dye Lifetime: 500 W-hours

Comments

Dye is also known as Sulforhodamine B. This dye is extremely light in powdered form and is easily airborne.

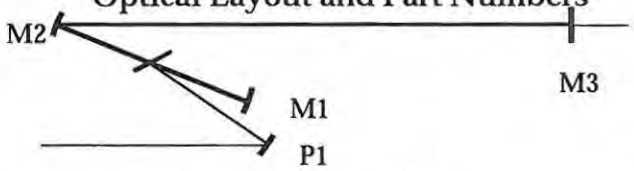
COHERENT 599 Dye Laser Fact Sheet

Dye: Pyridine 2/LC 7300

Power In vs. Power Out Curve

Data Not Available

Optical Layout and Part Numbers

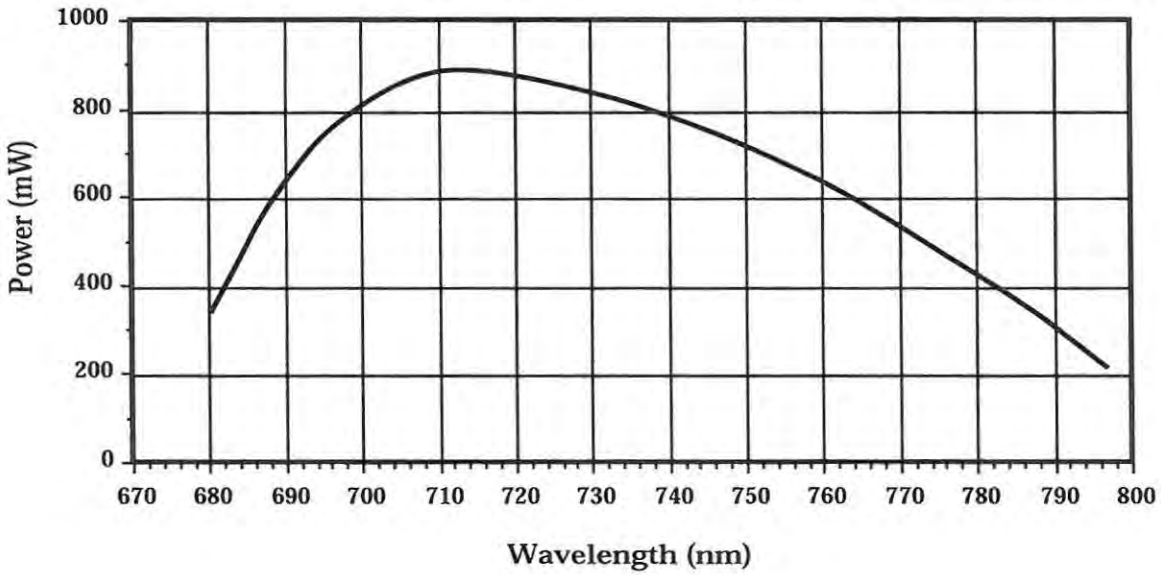


Mirror	Part Number	Rad.	Desc.	Dia.
P1	0406-721-01	75mm	Pump Mirror	4.0mm
M1	0158-787-09	50mm	End H. R.	12.5mm
M2	0158-788-09	75mm	Fold H. R,	12.5mm
M3*	0157-634-00	∞	Output Coupler	12.5mm

*Requires Optic Adapter P/N 0156-762-00

Dye Tuning Curve — Pyridine 2 — Non-Specified * See Note

Pump Power = 5.0 W @ 457.9-514.5 nm



* The numbers in this graph are not specifications, but have been achieved by Coherent, Inc. personnel.

Specifications

Pump Power: 5.0 W of Multiline Blue-Green

Output Power: 600 mW

Linewidth

3-Plate Birefringent Filter 40 GHz

Dye Information

Dye Recipe

Amount of Dye: 1.5 Grams
Premix Solvent: 200 ml Propylene Carbonate
Solvent: 800 ml Ethylene Glycol
Absorption: 80-85%
Dye Lifetime: 500 W-hours

Comments

Dye should be mixed in an ultrasonic mixer until completely dissolved; inadequate mixing will result in short dye lifetimes.

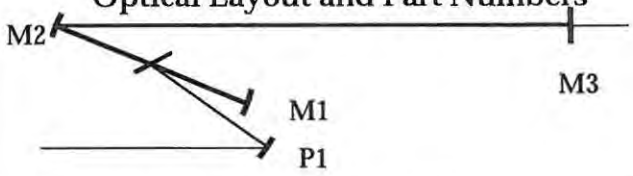
COHERENT 599 Dye Laser Fact Sheet

Dye: LD 700/LC7000

Power In vs. Power Out Curve

Data Not Available

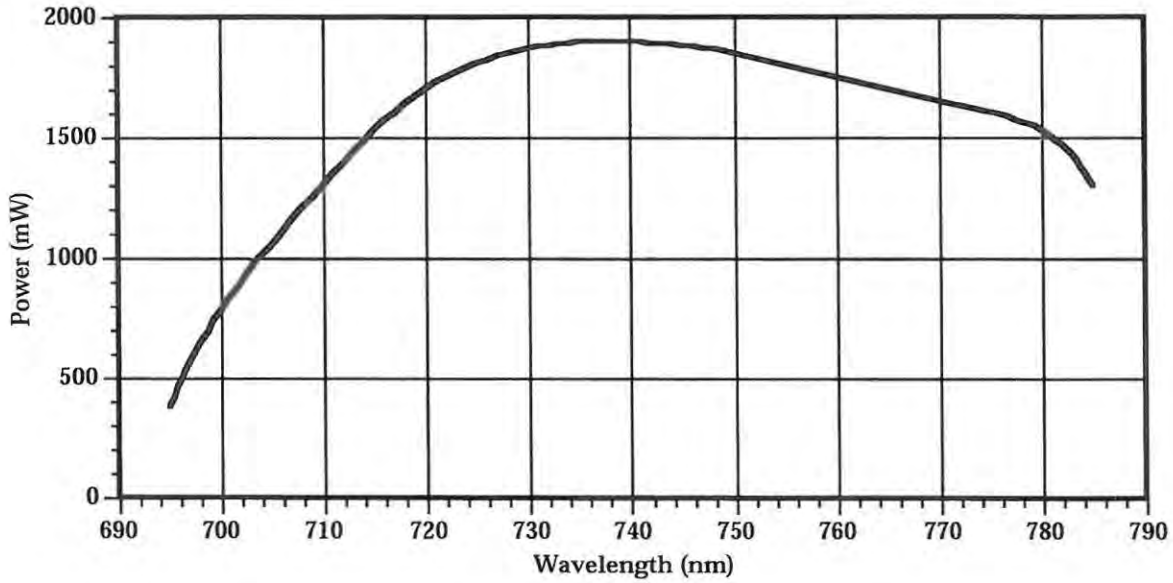
Optical Layout and Part Numbers



Mirror	Part Number	Rad.	Desc.	Dia.
P1	0406-721-02	75mm	Pump Mirror	4.0mm
M1	0158-787-09	50mm	End H. R.	12.5mm
M2	0158-788-09	75mm	Fold H. R.	12.5mm
M3	0157-271-00	∞	Output Coupler	25.4mm

Dye Tuning Curve — LD 700 — Non-Specified * See Note

Pump Power = 4.6W @ 647.1-676.4 nm



* The numbers in this graph are not specifications, but have been achieved by Coherent, Inc. personnel.

Specifications

Pump Power: 4.6 W of Multiline Red

Output Power: 1200 mW

Linewidth

3-Plate Birefringent Filter 40 GHz

Dye Information

Dye Recipe

Amount of Dye: 1.5 Grams
Premix Solvent: 200 ml Ethylene Glycol
Solvnet: 800 ml Ethylene Glycol
Absorption: 80-85%
Dye Lifetime: 800 W-hours

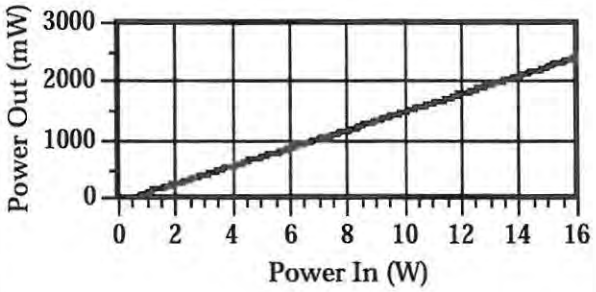
Comments

Dye should be mixed in an untrasonic mixer until completely dissolved.

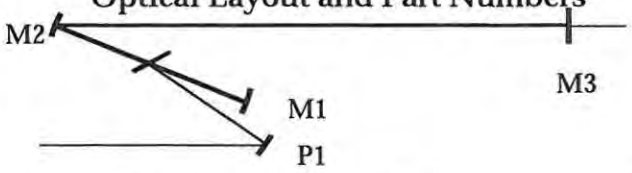
COHERENT 599 Dye Laser Fact Sheet

Dye: Styryl 9M/LC 8400

Power In vs. Power Out Curve



Optical Layout and Part Numbers

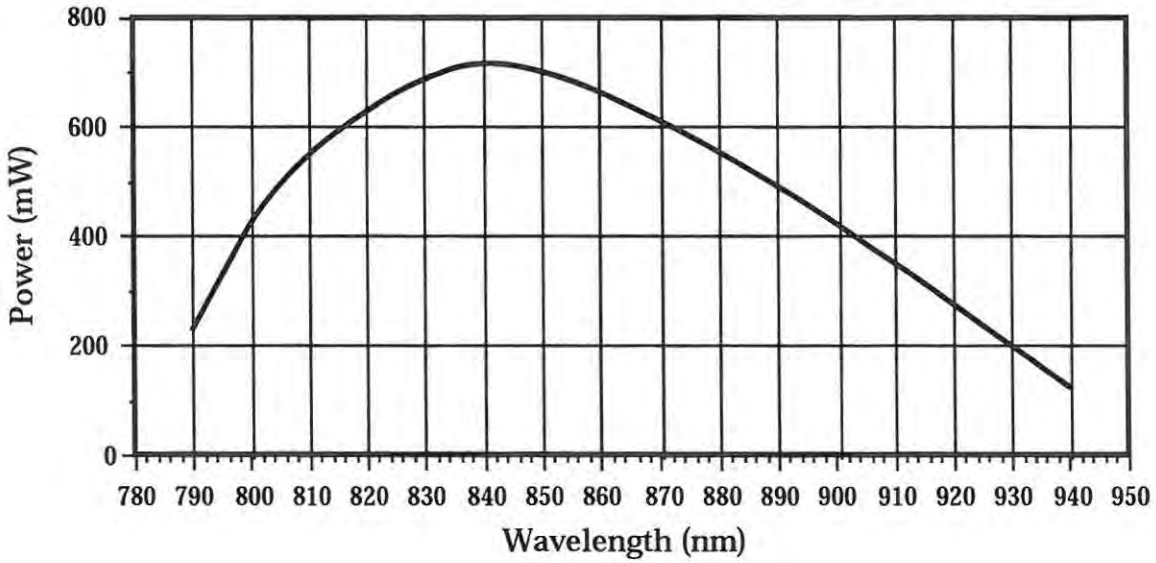


Mirror	Part Number	Rad.	Desc.	Dia.
P1	0406-721-01	75mm	Pump Mirror	4.0mm
M1	0158-787-11	50mm	End H. R.	12.5mm
M2	0158-787-11	50mm	Fold H. R.	12.5mm
M3*	0157-635-00	∞	Output Coupler	12.5mm

*Requires Optic Adapter P/N 0156-762-00

Dye Tuning Curve — Styryl 9M — Non-Specified * See Note

Pump Power = 5.0W @ 457.9-514.5 nm



* The numbers in this graph are not specifications, but have been achieved by Coherent, Inc. personnel.

Specifications

Pump Power: 5.0 W of Multiline Blue-Green

Output Power: 450 mW

Linewidth

3-Plate Birefringent Filter 40 GHz

Dye Information

Dye Recipe

Amount of Dye: 2.0 Grams
Premix Solvent: 300 ml Propylene Carbonate
Solvent: 700 ml Ethylene Glycol
Absorption: 80-85%
Dye Lifetime: 800 W-hours

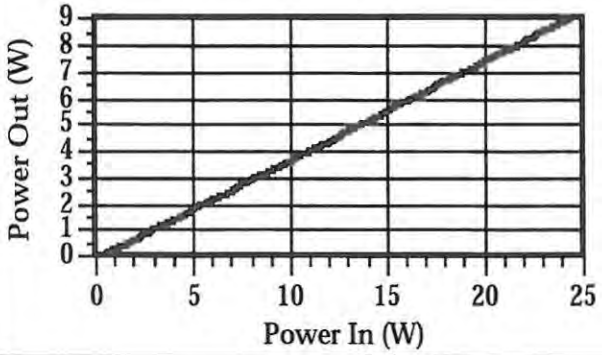
Comments

Dye should be mixed in an ultrasonic mixer until completely dissolved.

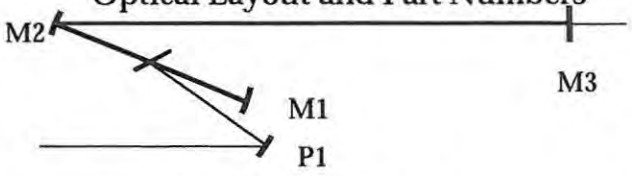
COHERENT 599 Dye Laser Fact Sheet

Dye: Rhodamine 6G/LC5900

Power In vs. Power Out Curve



Optical Layout and Part Numbers

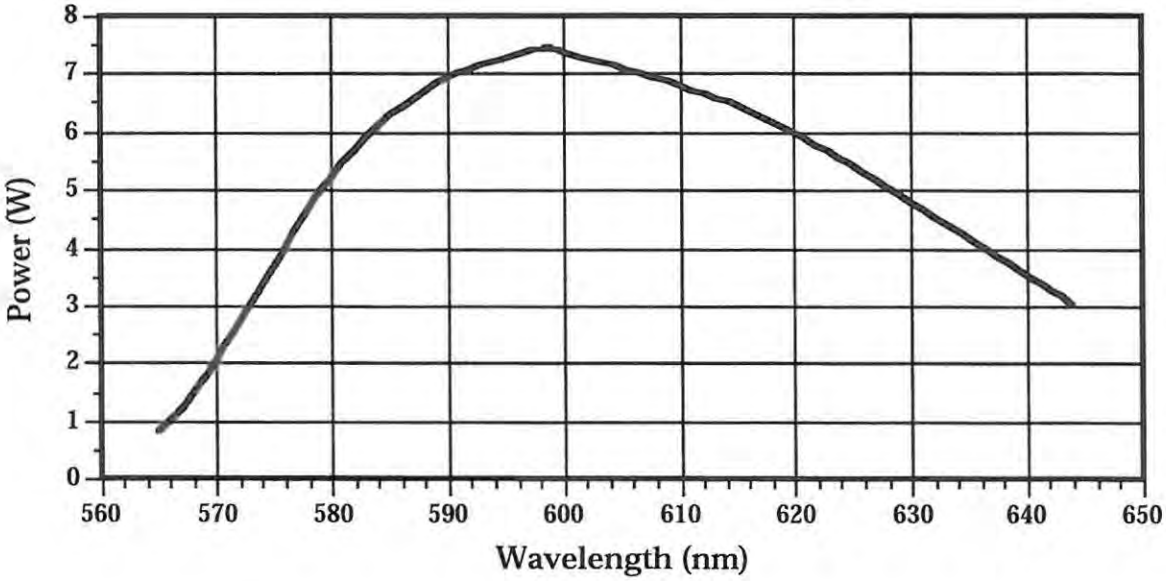


Mirror	Part Number	Rad.	Desc.	Dia.
P1	0406-721-01	75mm	Pump Mirror	4.0mm
M1	0158-787-07	50mm	End H. R.	12.5mm
M2	0158-787-07	50mm	Fold H. R.	12.5mm
M3	0500-836-03	∞	Output Coupler	25.4mm

Requires High Power Kit P/N 0159-110-00

Dye Tuning Curve — Rhodamine 6G High Power Pump — Non-Specified * See Note

Pump Power =20.0 W @ 457.9-514.5 nm



* The numbers in this graph are not specifications, but have been achieved by Coherent, Inc. personnel.

Specifications

Pump Power: 20.0 Watts of Multiline Blue-Green

Output Power: 4.0 W

Linewidth

1-Plate Birefringent Filter

Dye Information

Dye Recipe

Amount of Dye: 1.0 Gram
Premix Solvent: 50 ml Methanol
Solvent: 950 ml Ethylene Glycol
Absorption: 80-85 %
Dye Lifetime: 1000 W-hours

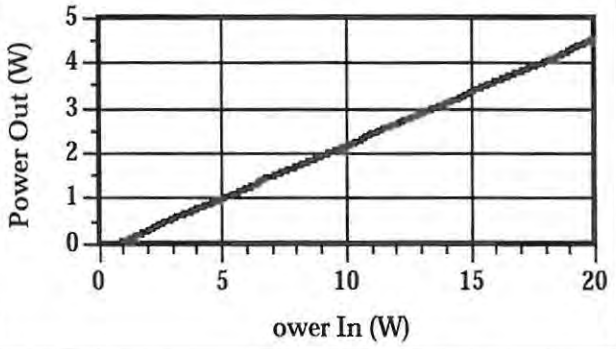
Comments

Transverse mode can contain some sub-structure and is elongated.

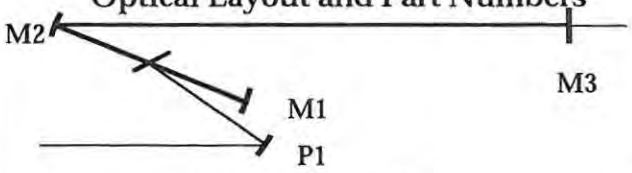
COHERENT 599 Dye Laser Fact Sheet

Dye: Kiton Red/LC 6200

Power In vs. Power Out Curve



Optical Layout and Part Numbers

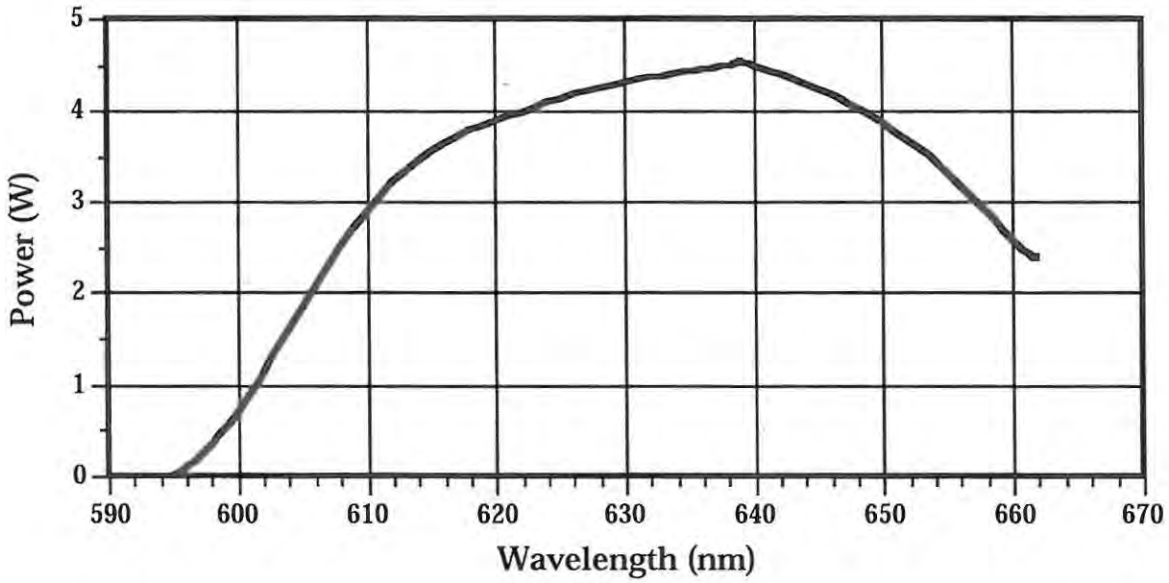


Mirror	Part Number	Rad.	Desc.	Dia.
P1	0406-721-01	75mm	Pump Mirror	4.0mm
M1	0158-787-08	50mm	End H. R.	12.5mm
M2	0158-787-08	50mm	Fold H. R.	12.5mm
M3*	0406-670-00	∞	Output Coupler	12.5mm

*Requires Optic Adapter P/N 0156-762-00 and High Power Kit P/N 0159-110-00

Dye Tuning Curve — Kiton Red-High Power pump — Non-Specified * See Note

Pump Power = 20.0 W @ 457.9-514.5 nm



* The numbers in this graph are not specifications, but have been achieved by Coherent, Inc. personnel.

Specifications

Pump Power: 20.0 Watts of Multiline Blue-Green

Output Power: 2.8 W

Linewidth

1-Plate Birefringent Filter

Dye Information

Dye Recipe

Amount of Dye: 2.5 Grams
Premix Solvent: 150 ml Methanol
Solvent: 750 ml Ethylene Glycol
Absorption: 75-80%
Dye Lifetime: 500 W-hours

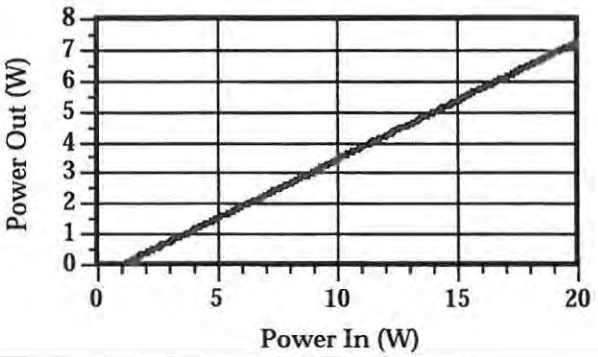
Comments

Dye is also known as Sulforhodamine B. This dye is extremely light in powdered form and is easily airborne. Transverse mode can contain some sub-structure and is elongated.

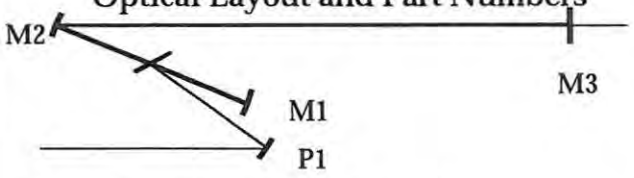
COHERENT 599 Dye Laser Fact Sheet

Dye: DCM Special/LC 6501

Power In vs. Power Out Curve



Optical Layout and Part Numbers

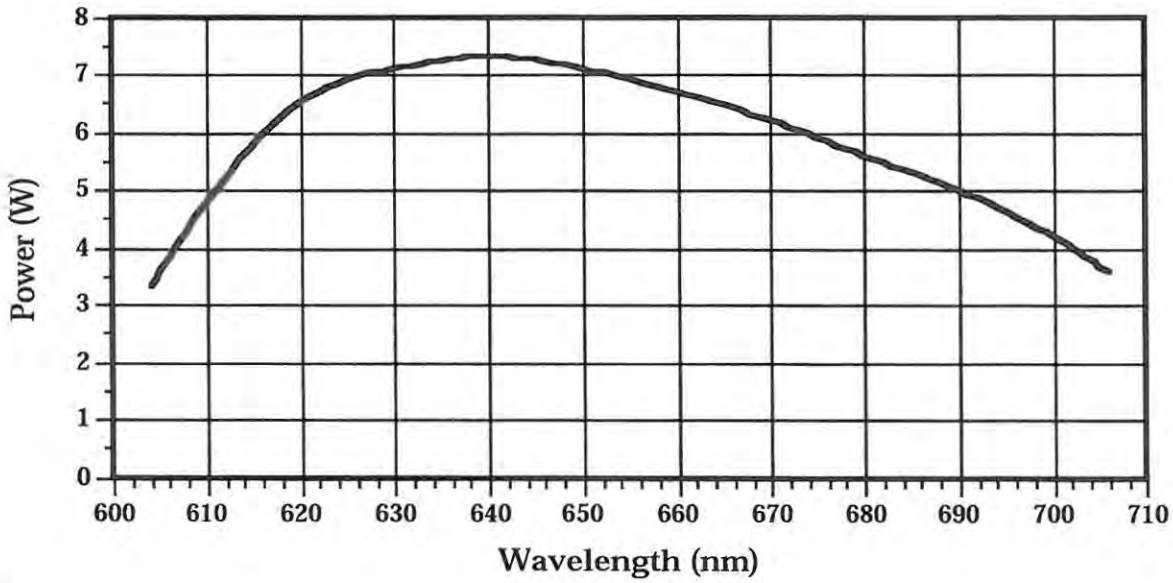


Mirror	Part Number	Rad.	Desc.	Dia.
P1	0406-721-01	75mm	Pump Mirror	4.0mm
M1	0158-787-08	50mm	End H. R.	12.5mm
M2	0158-787-08	50mm	Fold H. R.	12.5mm
M3*	0406-670-00	∞	Output Coupler	12.5mm

*Requires Optic Adapter P/N 0156-762-00 and High Power Kit P/N 0159-110-00

Dye Tuning Curve — DCM Special High Power Pump — Non-Specified * See Note

Pump Power = 20.0 W @ 457.9-514.5 nm



* The numbers in this graph are not specifications, but have been achieved by Coherent, Inc. personnel.

Specifications

Pump Power: 20.0 Watts of Multiline Blue-Green

Output Power: 4.0 W

Linewidth

1-Plate Birefringent Filter

Dye Information

Dye Recipe

Amount of Dye: 2.0 Grams
Premi Solvent: 400 ml Benzyl Alcohol
Solvent: 600 ml Ethylene Glycol
Absorption: 80-85%
Dye Lifetime: 400 W-hours

Comments

Dye should be mixed in an ultrasonic mixer until completely dissolved. The ethylene glycol should be free of water; this will prolong the dye lifetime. DCM Special (LC6501) contains a small amount of Kiton Red, which allows it to go into solution more easily, but does cause a blue shift in the tuning curve. Transverse mode can contain some sub-structure and is elongated.

OPERATOR'S MANUAL

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APPENDIX B
PARTS LIST

COHERENT

The following parts can be ordered by contacting Coherent Customer Service at 1-800-0367-7890 (within USA) or 1-408-764-4557 (outside USA), or your local Coherent representative.

DESCRIPTION		PART NUMBER
Birefringent filter (optic and optic holder): 1-plate 3-plate		 0158-391-00 0157-415-00
Jet nozzle		
Tool kit: Dowel pin, hardened, 5/32 x 1" Wrench, open end box Wrench, open end box, 1/4" Allen head wrench set, ball end Wrench, open end, 3/8 x 7/16" Wrench, cobination, 12 point, 1/2" Balldriver, hex head, 5/64", 3/32", 9/64", 3/16"	 Hemostat Hemostat, forcep, curved Tweezers Ruler Level, 2-way bubble, magnetic Tool roll, 28 x 20", 10 oz can	0162-019-00
Dye circulator		0158-151-00
Fuse, dye circulator, 3 Amp 250 V slo-blo		5110-0021
Filter cartridge, dye circulator		2603-0021
Water tubing, dye circulator		Bev-a line IV
High power kit Water hose tee with shutoff Output coupler, high power with optic adapter Water cooled beam dump		0159-110-00
Hose, dye input, 1/8" inside diameter, 1/4" outside diameter		
Hose, dye output, 1/2" inside diameter, 5/8" outside diameter		
Water interconnect kit		0500-732-00
Foot clamps (3 required)		0160-912-00
Optics (Refer to Table B-1)		--
Optic adapter		0156-762-00

Table B-1. Optics Part Numbers

DYE PART NUMBER	TYPICAL TUNING RANGE (nm)	END MIRROR M1 50 mm radius	FOLD MIRROR M2	OUTPUT COUPLER M3(1) Ÿ radius	PUMP MIRROR P1 75 mm radius
Exalite 392E Special order	375-410	0158-787-01	0158-787-01 50 mm radius	0160-994-00(2)	0406-721-01
Stilbene 1 LC 4100 P/N 1608-0021	395-435	0158-787-02	0158-788-02 75 mm radius	0155-272-00	0406-721-01
Stilbene 3 LC 4200 P/N 1608-0019	420-470	0158-787-03	0158-788-03 75 mm radius	0500-836-06	0406-721-01
Coumarin 102 LC 4800 P/N 1608-0007	458-520	0158-787-04	0158-788-04 75 mm radius	0500-836-07	0406-721-03
Coumarin 30 LC 5150 P/N 1608-0016	482-538	0158-787-05	0158-788-05 75 mm radius	0157-636-00(2)	0406-721-03
Coumarin 6 LC 5370 P/N 1608-0005	515-588	0158-787-06	0158-788-06 50 mm radius	0157-636-00(2)	0406-721-01
Rhodamine 110 LC 5700 P/N 1608-0001	535-600	0158-787-06	0158-788-06 75 mm radius	0500-836-03	0406-721-01
Rhodamine 6G(3) LC 5900 P/N 1608-0018	566-640	0158-787-07	0158-788-07(4) 75 mm radius 0158-787-07(5) 50 mm radius	0500-836-03(6)	0406-721-01
DCM Special(3) LC 6501 P/N 1608-0024	608-712	0158-787-08	0158-788-08(4) 75 mm radius 0158-787-08(5) 50 mm radius	0500-836-01 0406-670-00(2, 6)	0406-721-01
Kiton red(3) LC 6200 P/N 1608-0023	602-695	0158-787-08	0158-787-08(7) 50 mm radius	0406-670-00(2, 6)	0406-721-01

(1) 2 to 4% transmissivity.
(2) Requires optic adapter P/N 0156-762-00. Refer to Figure 7-4, item 4.
(3) Can be pumped by a low power or a high power (10 or more Watts) laser.
(4) Low power pump.
(5) High power pump.
(6) High power pump lasers (10 Watts or greater) require high power kit P/N 0156-110-00.
(7) Kiton red uses the same fold mirror optic for both low power and high power pumps.

Table B-1. Optics and Dye Part Numbers (Continued)

DYE PRT NUMBER	TYPICAL TUNING RANGE (nm)	END MIRROR M1 50 mm radius	FOLD MIRROR M2	OUTPUT COUPLER M3[1] Ÿ radius	PUMP MIRROR P1 75 mm radius
Pyridine 2 LC 7300 P/N 1608-0021	680-795	0158-787-09	0158-788-09 50 mm radius	0157-634-00[2]	0406-721-01
LD700 LC 7000 P/N 1608-0021	695-785	0158-787-09	0158-788-09 75 mm radius	0157-271-00	0406-721-02
Styryl 9M LC 8400 P/N 1608-0025	790-940	0158-787-11	0158-787-11 50 mm radius	0157-635-00[2]	0406-721-01

(1) 2 to 4% transmissivity.
(2) Requires optic adapter P/N 0156-762-00. Refer to Figure 7-4, item 4.

OPERATOR'S MANUAL

APPENDIX C
WARRANTY

COHERENT

Warranty

Tunable laser systems are warranted to conform to Coherent's published specifications and to be free from defects in materials and workmanship for a period of twelve (12) months. This warranty covers parts and labor. Travel time and travel costs for on-site service are included during the first ninety (90) days of the warranty period. For systems that include installation in the purchase price, this warranty begins at installation or thirty (30) days from shipment, whichever occurs first. For systems which do not include installation, this warranty begins at date of shipment.

Optical Products

Coherent optical products are unconditionally warranted to be free of defects in materials and workmanship. Discrepancies must be reported to Coherent within thirty (30) days of receipt, and returned to Coherent within ninety (90) days. Adjustment is limited to replacement, refund, or repair at Coherent's option.

Conditions of Warranty

On-site warranty services are provided only at the installation point within the United States. If products eligible for on-site warranty and installation services are moved from the original installation point, the warranty will remain in effect only if the Buyer purchases additional inspection or installation services at the new site. No warranty coverage is provided for systems outside the United States unless purchaser pays Coherent, Inc. international prices.

For warranty service requiring the return of any product to Coherent, Inc., the products must be returned to a service facility designated by Coherent, Inc. Buyer shall prepay shipping charges and shall pay any taxes and duties for products returned to Coherent, Inc. for warranty service.

Coherent, Inc. shall pay for return of all products to buyer, except where buyer is located in a country different from that of the Coherent Service Center. Installation and warranty service outside the United States are included in Coherent's price only if buyer pays Coherent, Inc. international prices.

All laser parts replaced under warranty shall become the property of Coherent, Inc. and must be returned to Coherent, Inc., 5100 Patrick Henry Drive, Santa Clara, CA 95054, or to a facility designated by Coherent, Inc. All laser plasma tubes must be carefully packed in the shipping containers provided by Coherent, Inc. prior to returning them to the factory.

Other Products

Other products not specifically listed above are warranted to, (a) conform to Coherent's published specifications and (b) be free from defects in materials and workmanship. This warranty covers parts and labor and is for a period of twelve (12) months from the date of shipment from F.O.B. point.

Responsibilities of the Buyer

The Buyer is responsible for providing appropriate utilities and an operating environment as outlined in the product literature and/or preinstallation manual. Damage to the laser systems caused by failure of buyer's utilities or failure to maintain an appropriate operating environment, is solely the responsibility of the buyer and is specifically excluded from any warranty, warranty extension, or service agreement.

The Buyer is responsible for prompt notification to Coherent of any claims made under warranty. In no event will Coherent be responsible for warranty claims later than seven (7) days after the expiration of the warranty.

Limitations of Warranty

The foregoing warranty shall not apply to defects resulting from:

- Components and accessories manufactured by companies, other than Coherent, which have separate warranties,
- Improper or inadequate maintenance by Buyer,
- Buyer-supplied interfacing,
- Operation outside the environmental specifications of the product,
- Improper site preparation and maintenance, or
- Unauthorized modification or misuse.

Coherent assumes no responsibility for customer-supplied material.

The obligations of Coherent are limited to repairing or replacing, without charge, equipment which proves to be defective during the warranty period. Repaired or replaced parts are warranted for the duration of the original warranty period only. The warranty on parts purchased after expiration of system warranty is 90 days. Our warranty does not cover damages due to misuse, negligence or accidents, or damage due to installations, repairs or adjustments not specifically authorized by Coherent.

Warranty applies only to the original buyer at the initial installation point in the country of purchase, unless otherwise specified in the sales contract. Warranty is transferable to another location or to another customer only by special agreement which will include additional inspection or installation at the new site. Coherent disclaims any responsibility to provide product warranty, technical or service support to a customer that acquires products from someone other than Coherent or an authorized representative. This includes any third party tube refurbishment provided in order to upgrade or maintain the operation of the tube.

THE WARRANTY IS EXCLUSIVE IN LIEU OF ALL OTHER WARRANTIES, WHETHER WRITTEN, ORAL OR IMPLIED, AND DOES NOT COVER INCIDENTAL OR CONSEQUENTIAL LOSS. COHERENT SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

OPERATOR'S MANUAL

GLOSSARY

COHERENT

Glossary

CDRH	Center for Devices and Radiological Health (U.S. Government)
CFR	Code of Federal Regulation
Fs	
Hz	Hertz or cycles per second (frequency)
kg	Kilograms = 10^3 grams
kHz	Kilohertz = 10^3 hertz
mg	Milligrams = 10^{-3} grams
MHz	Megahertz = 10^6 Hz
mJ	Millijoules = 10^{-3} Joules
ms	Milliseconds = 10^{-3} seconds
mW	Milliwatts = 10^{-3} Watts (power)
nm	Nanometers = 10^{-9} meters (wavelength)
psi	Pounds per square inch
W	Watts

OPERATOR'S MANUAL

INDEX

COHERENT

Model 599 Standing Wave Dye Laser Operator's Manual

Coherent Part Number 0170-465-00, Rev A